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Canadian Aeronautical Journal

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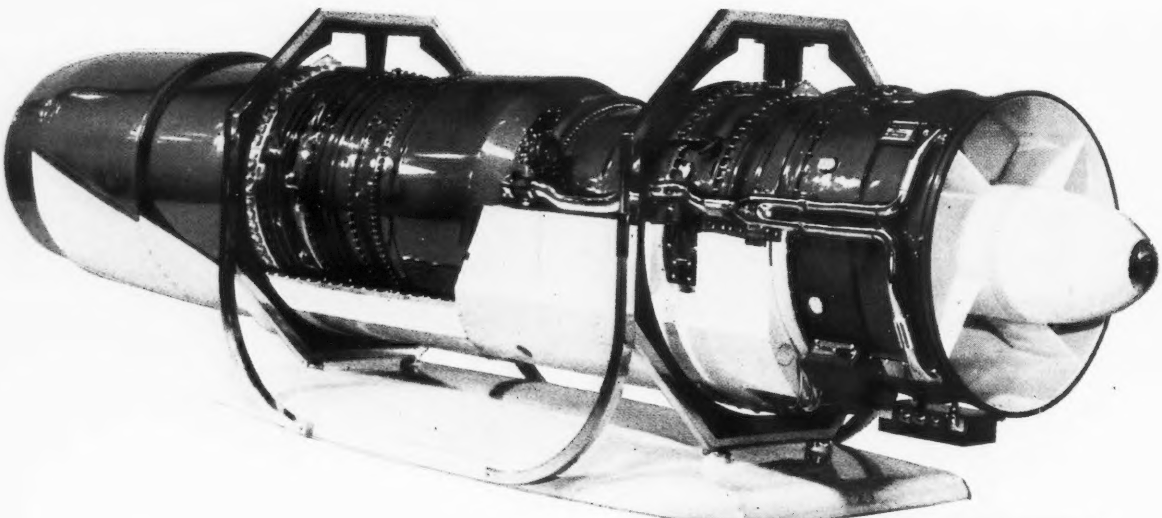

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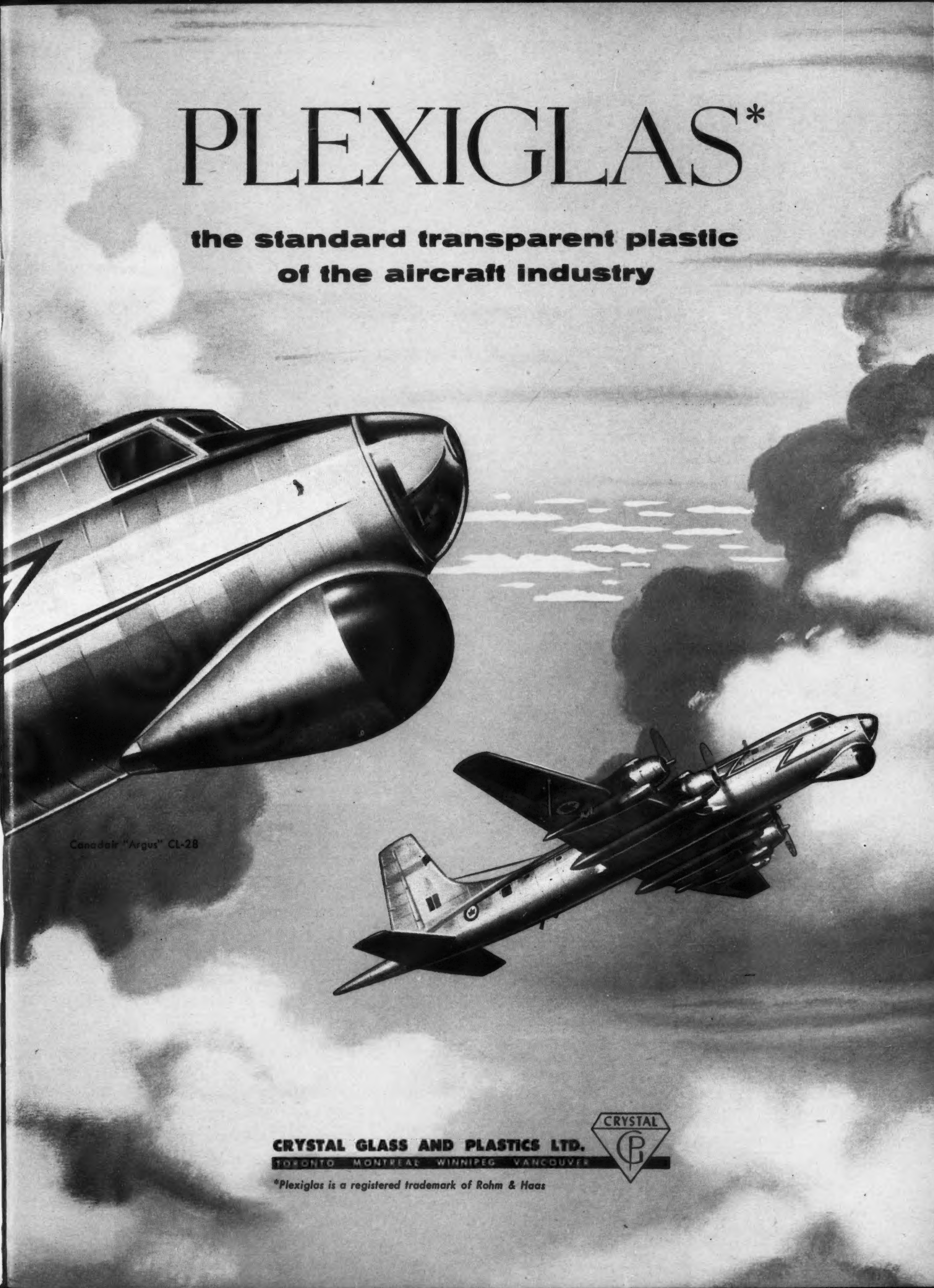
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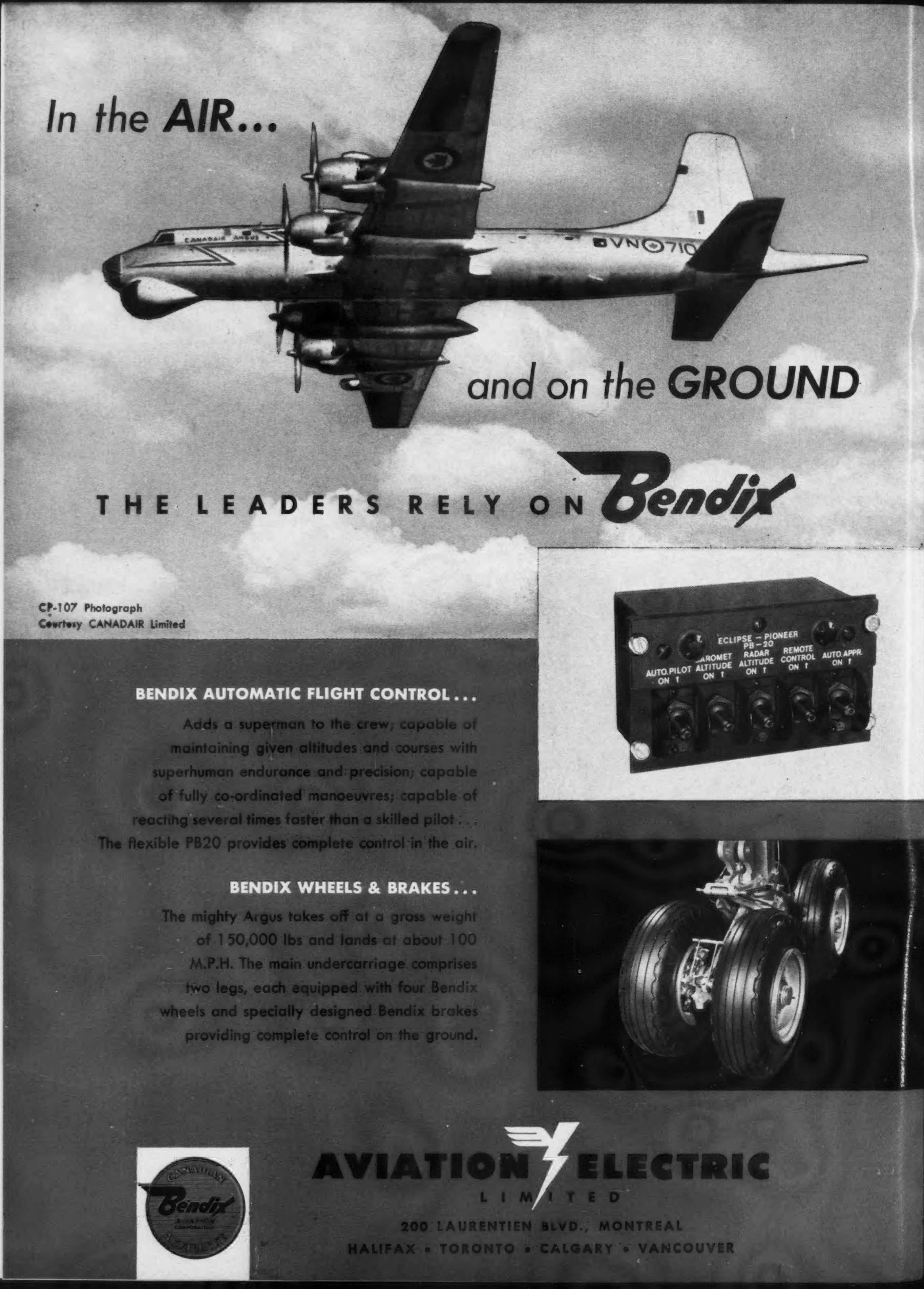
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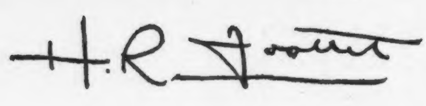
THE PRESIDENT 1957-58



EDITORIAL

THE PRESIDENT'S MESSAGE

OVER 5,000 years of tradition are behind us. From the earliest written records, dated about 3,000 BC, we find that the primitive Egyptian and Sumarian peoples had small groups of specialists woven into the fabric of their civilizations. These were the rudimentary architects, civil engineers, metallurgists and stone masons. They banded together in secret societies. Knowledge was hoarded like a miser's gold. The payment for betrayal of a technical secret often meant death.

Progress was slow. So time, eventually, washed all this away. Today our technical societies, such as the Canadian Aeronautical Institute, all work hard to distribute as much information as possible to as many members as possible. We in the C.A.I. have made some rapid strides in the few short years of our life. From the seed planted in the Montreal-Ottawa-Toronto triangle, we have branched and blossomed from Vancouver to Halifax. We have a fine Headquarters. We hold great banquets. We participate in civil and military aviation ceremonies. But, in spite of this impressive framework and show, our prime role is still to distribute aeronautical knowledge: by meetings, by articles in our Journal, by informal discussions. During my term of office as President, I hope I can sustain and foster this basic work. But it will take a true understanding by our supporting companies, and the solicited and unsolicited (and often unacknowledged) help of our members everywhere.

We don't have to go back very far in our scientific history to realize the importance of this undertaking. In the 17th Century a young Frenchman, named Pascal, became interested in the air. By a stroke of luck he heard about the work of the Italian, Torricelli. Torricelli had invented the barometer and proved that the air exerted a pressure over the surface of the earth. Pascal's brother-in-law, Périer, has told how the word was spread: "It was the Rev. Father Mersenne of the Order of Minims in Paris who first heard of it in France. The news was sent to him from Italy in 1644 and he in turn spread it abroad and made the experiment famous throughout the country to the admiration of all scientists. M. Pascal heard it from M. Petit, chief of the Department of Fortification, a very able scientist who had got it from Father Mersenne himself."

Four years after Toricelli's work Pascal built a barometer. He had his brother-in-law carry it up the Puy de Dôme mountain in central France. Thus he was able to prove that the air pressure dropped with increasing altitude. A significant advance had been made in our knowledge of air. But it had only come about after the scientific word had been passed through a long and tedious labyrinth of communication. Dr. James B. Conant, scientist and educator, commented on this in his book *On Understanding Science*. Said he, "The route by which Pascal heard of Torricelli's work illustrates the difficulties of publication before the scientific academies and the journals were established."

So in spite of our notable organizational accomplishments, this is still only the framework from which we can build a better and faster system for the distribution of aeronautical information. I hope with the help of the Council, our Headquarters, Branch and Section Executives, and members from coast to coast, that I can keep this flame of technical advancement burning as brightly as my presidential predecessors did. For this, I firmly believe, is the true pacemaker for progress.

GROUP CAPTAIN H. R. FOOTTIT
President 1957-58

A SYMPOSIUM ON

Foreign Objects in Aircraft, Engines and Airborne Equipment

A symposium, to consider ways and means of minimizing the hazards created by the presence of foreign objects in aircraft, engines and airborne equipment, will be held in Ottawa on the 24th October 1957.

It will consist of an open discussion of the problems involved and will be broken down under the following main headings:

(a) Operations and Maintenance
(b) Manufacture
(c) Design Requirements

At the conclusion of the discussion the results will be summarized and it is hoped that it will be possible to issue specific recommendations regarding future practice.

The meeting will occupy the full day.

Admission is restricted to members of the C.A.I. or I.A.S. and to representatives of those Sustaining Members, other Companies and Government Departments to which direct invitations have been sent.

Further particulars can be obtained from:

The Secretary,
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MID-SEASON MEETING

HOTEL VANCOUVER

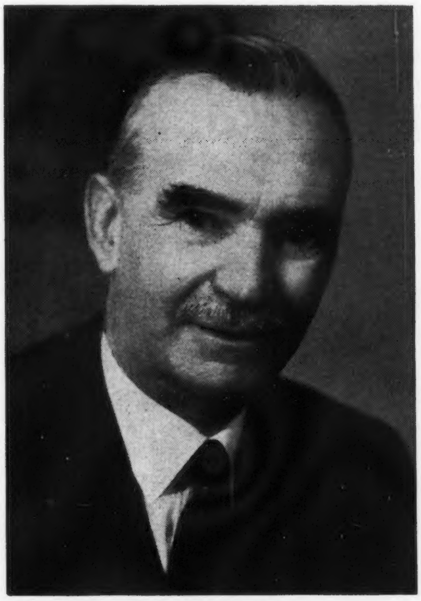
VANCOUVER

27th and 28th February, 1958

THE LESSER LIGHTS†

by E. T. Jones*

Ministry of Supply



Mr. E. T. Jones

INTRODUCTION

It is to me, Mr. President, a very great honour and privilege to be invited to take part in your fourth annual series of lectures and to be your guest speaker this evening and, on behalf of the members of the Royal Aeronautical Society, may I congratulate the Institute, through you Sir, on its achievements to date and ask you, Mr. President, if you will be good enough to convey to your members our very good wishes for the Institute's future.

The Institute's first President, Dr. Green, delivered in London in 1955 the Eleventh British Commonwealth Lecture and he spoke on "*The Growth of Aeronautical Research in Canada during the Post-war Decade*". In his paper, which is a most impressive catalogue of solid achievements, he reminds us among other things that Canada's first wind tunnel was built in 1902, that is, one year before the first powered aircraft took the air.

†Dinner Address read at the Annual General Meeting of the C.A.I. on the 27th May, 1957, in Ottawa.
*Director General of Technical Development (Air)

The wind tunnel, the first among the many tools the aircraft designer and his engineers have acquired, is still a fascinating and necessary capital facility and with these tools the aerodynamicist fashions the latest creations, area-ruling the body and placing the curves in the right places. I should at this point make it very clear, since my audience tonight is comprised of two so very different parts, parts that might perhaps be described as the dedicated and the delectable, that this most happy and desirable result of wind tunnel research can only, alas, be expected in the field of fluid motion — in other words, my reference is to aircraft bodies. The wind tunnel was quickly followed by structural testing equipment and propulsion facilities and for many years the aerodynamicist, the structural engineer and the propulsion engineer provided the data from which the aircraft designer modelled the ensemble. The exterior form of some of the finished articles were works of art, no less in merit and elegance than some of the universally accepted show-pieces but, being essentially utilitarian, they were also essentially consumable.

Today, whether we speak of the military weapons system, manned or unmanned, or the transport aircraft, the criteria of a successful design are not judged against artistic or aesthetic standards but by the standard of the engineering techniques employed and the reliability of fixed and removable equipment, because it is these features which determine its power as a weapon to seek and destroy a target and the degree of comfort and peace of mind enjoyed by the passengers carried. The aerodynamics of the airframe and its structural integrity, whatever air vehicle we have in mind, are still most important matters and the efficient integration with the airframe of the system of propulsion is an exercise of considerable importance and complication. Nevertheless the demands for higher and yet higher speeds and for greater and greater ranges have brought other requirements to the forefront.

Within the exterior form there is now a multitude of comprehensive and highly sensitive organs, each of which must function the instant it is commanded. Today, we identify the most important part of a military air vehicle as that which has failed to function at a critical time of an operational sortie and the next most important part as that which has rendered the vehicle unserviceable at the time the vehicle is required. When a commodity is cheap and numerous and time is not a prime factor,

the obvious is often overlooked, but assuming that there are no redundant parts or systems then the structural and functional integrity of all parts and systems are of equal importance. The military air vehicle of the future, whether manned or not, is never likely to be cheap; once programmed and launched it must successfully complete its mission and be at all times instantly available. The performance of transport aircraft too is closely approaching sonic speeds and the cost of these aircraft, in both effort and money, is also very high. Apart from the cost, however, the load of people they will carry is far too valuable for its safety to be vested in any branch of engineering which does not strictly adhere to the highest codes of practice of the day.

Possibly for more years than they should, the classical subjects of aerodynamics, structures and propulsion have claimed most of the glamour from the science and engineering of aeronautics and we still find today "aeronautics" to most young men of science means no more than "aerodynamics". To explore the mysteries of fluid motion round the various air vehicle configurations that can now be persuaded to fly through the transonic to supersonic speeds and thence even to the hypersonic regime, is indeed a fascinating and fruitful exercise but the higher the speed of the vehicle the more it must rely for its operational capability on the precision and reliability designed and built into its mechanisms.

The arrow, which became a feature in the armoury of Alexander the Great and which was produced in 1066 in its tens of thousands for the Battle of Hastings, was an effective weapon only if the hands of the expert launched it. On the other hand, the effectiveness of the modern version of this particular weapon is essentially vested in the designer and constructor. Whether we speak of the ballistic rocket, the winged manned or unmanned military vehicle or the passenger carrying aircraft of the future, no matter how excellent the guidance system or how expert the pilot may be, the ability to complete successfully an operational mission is vested more or less in the standard of the engineering techniques and skills built into the vehicle and on the balance given by the designer to the conflicting claims of all the specialist groups concerned. For these reasons, together with the fact that there is an acute and universal shortage of scientists and technologically trained men, I propose to concentrate this talk on some of the lesser lights of aeronautical glamour — those lights of humble origin but whose scientific and engineering content are no less intense than the most brilliant of the classical highlights.

AUXILIARIES

Let us consider the impact on aeronautics of the science and engineering of electricity and the consequential reaction on present day electrical practice. From the electrical point of view aeronautics, historically considered, reveals three periods. Originally the magneto was the sole representative of the profession and, being a part of the engine, the aircraft constructor had no need to employ, either directly or indirectly, personnel trained in electrical engineering. This period of powered flight extended for about ten years and ended when someone desired to fly in the dark and the electrolytic battery became a standard item of equipment. To the battery were added lighting circuits, wind driven generators and primitive communication equipment. During this second period the need arose for power to operate flaps, wheel brakes, constant speed propellers, retractable undercarriages, bomb doors and bomb release mechanisms, telecommunciation equipment etc. and so the pneumatic engineer, the hydraulic engineer and the electrical engineer could be found jostling each other to capture favour with the aircraft constructor. These alternative forms of power, each with their special attractions, became known as auxiliary power supplies and gradually new groups of engineers were added to the profession of aeronautics. The third electrical period can be identified with the fitting, as normal practice, of automatic pilots, search radars, fire control systems, electronic navigational aids, electronic computors, automatic approach aids, electrical flight instruments and powerful electric power supply systems. This period is mainly of post war origin and the electrical power required on a modern aircraft is at least one order greater than proved adequate during the war years. These demands for electrically operated appliances, crowding on each other so quickly, caught the aircraft constructor unprepared to deal adequately with the miniature electric power house which was beginning to take command of his creations. Further, these airborne electric power stations and their appliances, unlike ground installations, are required to function through a wide range of temperature, pressure and humidity and to be immune from the dust, grit and sand which at times envelop the vehicle before it becomes airborne.

To refer today to the electric power supply and the electric circuitry by the inadequate term *auxiliary*, as though they have but a secondary influence on the operational capability of a modern air vehicle, whether civil or military, is to underrate considerably not only their importance but also the skill and calibre of the men required to design, construct and integrate them with the systems they have to operate. Accepting the propulsion system as representing the muscle which gives the modern air vehicle its performance in speed and climb, so must we realize that the electrical system represents the heart which makes the equipment pulses beat to give the vehicle an operational capability.

Though once in fact a lesser light, the design of the electrical system is now an exercise of all the skills of this growing electrical-cum-aeronautical profession and nothing less than the highest codes of practice are acceptable. Thus, highly professional electrical engineers can get full reward for their labours in the profession of aeronautics and they should be given as much freedom of choice as possible and a voice in the councils of compromise.

PHYSICS

It is of interest to examine why, of late, there is an ever increasing use of physicists in fields which traditionally belong to the engineer. Undoubtedly, one of the reasons is that in order to increase the efficiency with which a given objective or process is achieved, or to make possible the achievement of such an objective, the physical phenomena on which this depends must be clearly understood. When, in Neolithic days, a small stream had to be spanned a series of logs could be used whose size could be graduated until they did not break

under the passage of man; logs were freely available; so too were the men to test them. Today man is much more ambitious and sets himself increasingly sophisticated objectives. The bridging of the Tacoma Narrows, where success was achieved through disaster, involved a full knowledge of wind structures, fluid flow characteristics and of loadings due to structural oscillations, so that a clear picture of the physical causes of the oscillatory failure could be made available to the engineer. Another cause of the penetration of the physicist into the engineer's domain is the ever increasing difficulty of measuring some of the quantities which the engineer must know. Though the engineer is today relying more and more on close collaboration with the physicist in order that his ends can be achieved, the reverse is also true. A new application of physical principles points the way to a new objective; radio, television, radar and atomic energy, all of which were born in the physics laboratories, could only be exploited to the full by the physicist collaborating closely with the engineer.

These are but a few of the many reasons why we find engineers and physicists today jointly engaged in common problems and it is not surprising that in aeronautics, where it is a sin in the eyes of the profession to use more material than is necessary and a crime against humanity to use too little, we meet profound problems in physics and engineering.

If all the people in Canada were assembled at Malton airport, enjoying the world's most gigantic cocktail party, they would generate no more noise than one CF-105 will make in takeoff. To state the problem of aircraft noise in such terms is not to suggest that the CF-105 will be noisier than other turbojets of similar thrust, but to illustrate that, while the continuous noise generated by the party would be intolerable, the aircraft noise would not, because the peak noise at any one place and time would be momentary. However, the busy terminal airport will slowly but surely approach the intolerable state and it is up to the physicist and the engineer to retard this approach to the best of their ability. Unfortunately, and unlike the distillers who have one common objective only in view, the aeronautical sciences are an amalgam of conflicting urges. The operator cries forward, with more range, more speed and more load, and while some of the Institute's members strive to meet his demands their colleagues are at their wits end to know how they are going to suppress to a tolerable level the greater noise levels these more powerful aircraft will generate.

The suppression of aircraft noise – not to be confused with supersonic bangs – is important for three reasons. First, and the easiest to deal with, is the noise inside the cabin of civil aircraft. The problem here is to absorb as much of the noise as necessary in the shell forming the cabin and so the weight and bulk of the material that can be used for this purpose is dependent on a satisfactory compromise between a tolerable noise level and a useful payload. Secondly, there is the noise external to the aircraft, which has its maximum nuisance value at airports. This is a more fundamental problem because it is well known that a large noise can be generated by the expenditure of a little energy – for example, a baby crying or the sergeant major on the parade ground – and that air is a poor sound absorbing medium. The main source of noise is the high velocity jet stream and to suppress this or to reduce its velocity would at the same time cancel or reduce the engine thrust. Measures such as reducing the shear velocity through the jet stream and smoothing the eddies around its periphery have an appreciable effect but before much can be done a more complete understanding of the physics of noise generation will be needed, particularly as jet stream velocities will continue to rise to meet the demands for greater takeoff thrusts. Thirdly, the skin of the aircraft, and indeed the structure itself, can suffer failure under the severe vibration induced solely by the noise of the jet. We are far from a full understanding of the mode of creation and transmission of such vibrations and of the behaviour of different kinds of aircraft structure when subject to jet noise.

Very intense sound can be harmful; heavy intermittent traffic noise at 100 decibels is not, but at 130 decibels it can cause deafness and the human body should never be exposed to a noise measuring 150 decibels or more, no matter what head protection is provided. Such intensities of noise would be realized very close to the turbojet engines of powerful aircraft and near a guided missile launching ramp. But don't let us get too dismayed; 150 decibels represent to the man in the street a noise sensation about 30 times as great as 100 decibels, but to the physicist, who works in terms of energy, 150 decibels would represent 100,000 times the energy of 100 decibels and there is little danger of this energy level being reached even at a reasonable distance from an aircraft. In addition, the mathematicians tell us that the noise from the jet increases roughly as the eighth power of the jet speed relative to the air and so one way of reducing jet noise without reducing thrust is to increase the jet area for the same mass flow or to employ the bypass type of engine. Other things being equal, it also pays to spread a circular jet into a long narrow jet so that the application of the jet flap principle may help in the overall problem of reducing jet noise.

ESCAPE

Nature, it has been said, did not design man to fly but it is probable that man never accepted this as a fact of life until he was forced to choose between making his escape or meeting his doom with his aircraft. When the first item of escape equipment was developed, I recall the appreciable opposition of observers to the order that henceforth all crews were to wear it as part of their flying clothing. In those days most aircraft had open cockpits and observers required some freedom of manoeuvre and so it appeared to them that the hand grip of the parachute might get wrenched from position and the wearer dragged overboard. This did, in fact, happen on a few occasions but as closed cabins replaced open cockpits this objection was gradually eliminated and so too was the need to wear goggles. At that time speed seldom reached 130 mph and rarely was a height of 15,000 ft exceeded. The physiologist, the psychologist and the physicist played little, if any, part in the science and engineering of aeronautics at that time but now that the speed and height records for manned aircraft have risen to 1,132 mph and 66,000 ft respectively, we find the disciplines of each of these professions must be harnessed to the skills acquired by the aeronautical

Figure 1

engineer to ensure the degree of flying comfort that a tranquil mind alone can induce.

In the early days of civil aircraft, the parachute, accepted previously but with reluctance in some military aircraft, was again the subject of much controversy and I am sure the audience that I am now honoured to address will agree with me when I suggest that experience has shown the negative decision to have been right, for, as we shall see later, parachutes alone would be of little use as an escape device from most civil aircraft.

Except after long acclimatization, man cannot live unassisted above 20,000 ft and above 30,0000 ft sustained life is not possible in the atmosphere obtaining there. Nevertheless, passenger carrying aircraft flying over long distances seldom fly lower than 20,000 ft and future long distance civil aircraft will cruise at and above 30,000 ft. Lack of oxygen at high altitudes is not the only factor, extreme cold and reduced pressure are contributory influences.

Until about 15 years ago there was no serious technical problem but nowadays most aircraft are of high performance and they all have pressure cabins. Before an escape can be made and assuming a personal supply of oxygen is available, some part of the cabin, say, a door, canopy or hatch, must be detached to provide an exit. All occupants would then have to survive under reduced pressure and temperature that would immediately occur, climb through the exit, hit the atmosphere at the speed of the aircraft, which would be sufficient to tear off clothing and break bones, and then descend by parachute. There are difficulties at each stage of these operations. Firstly, it is difficult in a pressure cabin to provide a structurally sound door which is jettisonable. Secondly, if jettisoned, the door may hit the tail and, thirdly, the oxygen supply line must not be severed. Fourthly, at speeds above 180 kts it is not possible to get out unless one is pushed. Finally, having emerged and missed striking other parts of the aircraft, the parachute must not be opened until 20,000 ft has been reached and during the free fall the body performs violent manoeuvres with risk of losing consciousness. To overcome these difficulties on military aircraft, research and development is being pursued on ejection seats, shielded doors and hatches, personal mobile oxygen equipment, automatic barometric parachute release equipment, pressure suits and "divers" helmets and it is well known that many spectacular ejections resulting in safe "landings" have been made from medium/high speed aircraft, both from high and low altitudes.

The design of pressure suits suitable for airmen is more complex than for divers because, unlike the diver's suit, which maintains a balance of pressure, the airman's suit must be inflated to a pressure in excess of the surrounding atmosphere. A complication which is common to both is the need for providing an opening visor in the headgear and those of us who have experienced when on parade the agonies of a fly making a tour of the nose (Figure 1), where one can do no more than squint and squirm, will agree that a visor is no luxury.

Military manned flight, where provision is made for escape, poses problems in research and development of aircrew equipment and cabin structures that must rank with the most profound, but in none of the aeronautical sciences can the reward of success be so high and we applaud not only the courage of the men who are able to continue life because of these facilities but also the men of diverse skills who by collaboration, ingenuity and tenacity of purpose make escape possible. Unlike the military aircraft, where the probability of combat is a

Figure 2

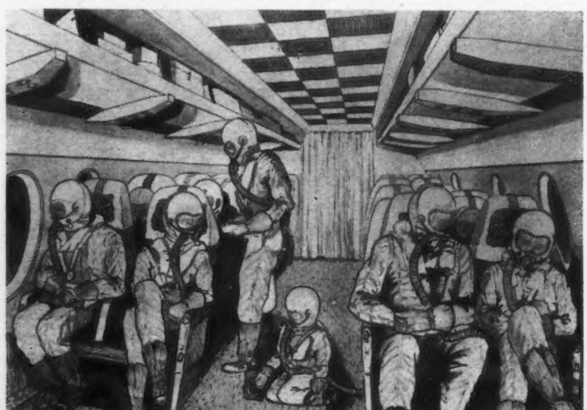


Figure 3

design consideration, civil aircraft operate in a peaceful environment and, in consequence, provision for escape is not a design requirement. However, I wonder if we, the air minded public, ever give thought to the clothing we might be called upon to wear in the luxury airliner of today if those far sighted aeronautical engineers and operators of yesterday had not rejected at the outset the parachute and decided instead to put the equivalent weight into the structure and its systems to ensure maximum safety for the overwhelming majority.

Instead of looking relaxed and contented as in Figure 2 we would look tense and depressed as in Figure 3 and the 15% increase per annum in air travel the established airlines are now planning would not be for this world.

AUTOCONTROL

Apart from crew equipment, internal installations, flying aids and the design of the vehicle itself, supersonic flight speeds have given prominence to some of man's own design limitations – limits not of his structure nor of the aerodynamics of his external form but of the range and sensitivity of some of his sensing organs – and the reproduction of these in synthetic form, so that their functional ranges can be increased to match future flight speeds, is already providing exercises in all fields of science and branches of engineering.

CONCLUSION

Thus, these more humble lights of aeronautical glamour, which the quest for speed has put in finer focus, are now easily seen against the background of the aerodynamic, structure and propulsion spotlights which, for so long unaccompanied, have illuminated the ever expanding aeronautical stage.

SPECIFIC AEROMEDICAL PROBLEMS IN HIGH PERFORMANCE AIRCRAFT†

by S/L R. A. Stubbs*

Institute of Aviation Medicine

INTRODUCTION

THE dimensions of the aeromedical problems involved in a high performance aircraft can be most easily appreciated by careful examination of the flight envelope of the aircraft. The flight envelope of a hypothetical high performance aircraft is shown in Figure 1. The vertical axis represents altitude in thousands of feet. The horizontal axis represents Mach number. Curves of true air speed, indicated air speed and dynamic pressure are superimposed for convenient reference. The heavily drawn curve represents the operating boundary or flight envelope of the aircraft. The region to the right and below the curve is either unattainable, or to be avoided. This may be due to engine power or airframe speed limitations.

We will consider the aeromedical problems as they arise, from the effects of altitude, airspeed and their combination.

ALTITUDE

The principal manifestations of increasing altitude are reductions in total atmosphere pressure, oxygen partial pressure, and ambient air temperature. At 18,000 ft these pressures have fallen to one-half their values at sea level. By 53,000 ft they are one-tenth, and by 100,000 ft they are one-hundredth their sea level values. It is well established that oxygen must be added in a progressively increasing percentage to ambient air for breathing purposes above 10,000 ft in order to maintain a useful, performing brain. By 38,000 ft, 100% oxygen at ambient pressure is only sufficient to maintain an effective breathing environment of 10,000 ft. It is the oxygen partial pressure in the lungs which is the effective agent in achieving oxygen saturation of the blood and, subsequently, the body tissues. Above 38,000 ft, 100% oxygen at ambient pressure is not enough. The oxygen must be supplied at sufficient pressure to maintain the oxygen partial pressure at the 38,000 ft total pressure equivalent. For example, to sustain a useful consciousness at an altitude of 50,000 ft, where the total pressure is 1.69 psi absolute, requires that the oxygen pressure delivered to the lungs be at least the pressure equivalent to 38,000 ft or 2.99 psi absolute. A pressure differential of 1.3 psi is thereby established in the lungs above the ambient pressure. This procedure is called pressure breathing. Failure to provide this minimum oxygen pressure results in loss of useful consciousness within fifteen seconds and total collapse follows rapidly.

With regard to the effect of the reduction of total pressure, incidents of physical discomfort begin to occur above 20,000 ft. The incidents are due to difficulties in eliminating trapped gases in the stomach and intestines, and nitrogen in the body tissues.

On reaching the 35,000 ft level, a considerable percentage of the aircrew population find themselves in some form of physical distress after as little as ten minutes' exposure. The actual percentage of personnel involved and the magnitude of the distress are dependent on many factors. These include age, obesity, emotional state, rate of ascent, temperature, duration of exposure and previous decompression experiences. Evidence indicates that the effects of exposure may be cumulative. Much of the early work in this field does not permit direct extrapolation to the new situation, principally because of increased ascent rates and extended exposure times at higher levels.

On ascent, the ambient air temperature drops at a rate of approximately 4°F every thousand feet, attaining an average value of −65°F at 35,000 ft. During further ascents up to altitudes of 90,000 ft little temperature change has been observed. This is called the 'Isothermal' region of the earth's atmosphere. The best approach to these temperature and pressure problems at the present time is the pressure cabin, which is designed to create an atmosphere and climate about man. It would be of great advantage to arrange the pressure in the cabin at a level such that an altitude of 10,000 ft would not be exceeded regardless of the altitude achieved by the aircraft. However, from an engineering point of view, this imposes extreme pressure differential stresses on the aircraft structure and, from an aeromedical point of view, presents one further problem. This is the problem of explosive or rapid decompression. The problem arises when a hole develops in the cabin structure permitting the pressure contained therein to rapidly dissipate into the ambient air. When this happens, in times shorter than 200 milliseconds, there is insufficient time to permit the venting of the respiratory gases and thus stresses are imposed on the tissue structures of the respiratory system, which might prove fatal. In solving the cabin

†Paper read at the Annual General Meeting of the C.A.I. in Ottawa on the 28th May, 1957.
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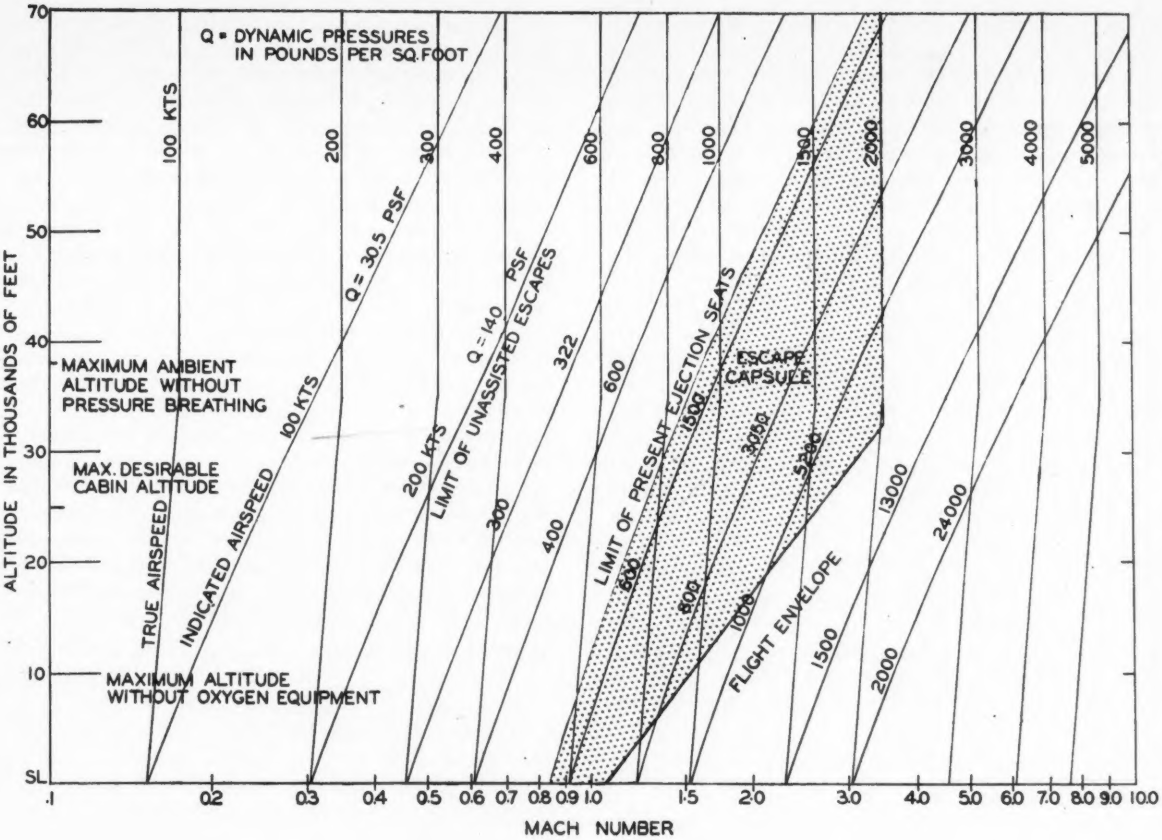

Figure 1

Hypothetical flight envelope of a high performance aircraft

pressurization problem, a compromise must be reached between the ultimate required to maintain a man in a comfortable environment below 10,000 ft and one which will ensure safety should an explosive decompression occur due to cabin failure during normal flight, or in combat. One of the big factors to be considered in this decision is the cabin volume. With the large cabin volumes encountered in commercial air transports and bomber type aircraft, a sizeable hole may not permit the cabin pressure to fall as quickly as mentioned above. On the other hand, in a fighter type aircraft with a relatively small cabin volume, even a small hole will permit the cabin pressure to diminish rapidly. It has been generally agreed, therefore, that for fighter type aircraft of the type whose flight envelope we are discussing, a maximum cabin pressure differential, regardless of its altitude, would be 5 psi. For this cabin pressure differential and the aircraft operating at 70,000 ft, the cabin altitude would be about 25,000 ft. Air to pressurize the cabin is currently obtained from the aircraft engines and is temperature regulated and distributed to permit the ventilation of the cabin. As altitudes increase, it becomes more and more difficult to obtain air for pressurization purposes, principally due to the low ambient air density at higher altitudes. Consequently, more power must be taken from the engines to achieve the pressurization and extreme air temperatures result in the compression process. In addition to this, there is the question of ozone which exists at altitudes just above those we are dealing with today (90,000 ft), the compression of which brings about toxicity problems. There is little doubt, therefore, that at altitudes above 70,000 ft, it will not be feasible to bring in outside air, compress it and use it for pressurizing and ventilating the cabin. This brings us into the region of the 'sealed cabins'. For these the pressurizing and ventilating gas will have to be carried in a compact form and, for flights of an extended duration, some form of purification and recirculation will be required.

To return to the aircraft under consideration, we have specified a pressure cabin with a maximum pressure differential of 5 psi to establish a maximum altitude of 25,000 ft while the aircraft is at 70,000 ft. The question arises, however, "What do we do for the occupant should the cabin pressurization system fail and subject the occupant to the aircraft altitude?" This has been one of the major concerns and activities of the Institute of Aviation Medicine. At this point, advice must be sought from the weapons system specialists for the loss of pressurization may be as vital to them as it is to us. There would be little point in trying to maintain the man in a pressurized garment at the operational altitude of this airplane, if the weapons system is non-functional.

The philosophy in the design of any personal pressure

garment must be to provide the maximum protection with minimum physical encumbrance to the aircrew member. This means that the operational role and the characteristics of the aircraft must be clearly defined. The major considerations in the garment design are the maximum operational altitude, the required duration at that altitude, and the rate of descent capabilities of the aircraft. If the maximum altitude is below 48,000 ft and an immediate descent can be made to below 38,000 ft, a pressure holding oxygen mask meets the requirement. If the altitude is between 55,000 and 48,000 ft, a pressure headpiece and pressure vest are required. The pressure headpiece ensures the holding of the higher differential pressures necessary and permits pressurization of the eyes and ears. The pressure vest provides external counter-pressure to assist breathing, particularly during the exhalation phase, at these higher differential pressures.

For altitudes above 55,000 ft counter-pressure must be applied to additional areas of the body, particularly to the lower limbs, to prevent blood pooling. This can be achieved by pressurizing an existing anti-g suit to the same pressure or to a slightly higher pressure than that of the vest and headpiece.

Since this garment assembly does not pressurize the entire body area, its use is restricted to a maximum altitude of 65,000 ft, for a maximum duration of about five minutes after which a rapid descent must be made to at least the 38,000 ft level.

If the operational requirement dictates that the aircraft must remain above 30,000 ft for extended periods of time, then, in the event of a cabin pressure failure, a garment capable of duplicating the protection afforded by the pressure cabin must be used. The garment which fulfils this requirement is the emergency full pressure suit. Since garments of this type give rise to problems of mobility and ventilation, they cannot be considered as direct replacements for the pressure cabin. The simpler garment assembly, consisting of a pressure headpiece, vest and anti-g suit, is therefore recommended when the operational role of the aircraft permits its use.

SPEED

Let us now turn our attention to considerations of speed as they give rise to aeromedical problems. Speed per se presents no physiological problems. The time rate of change of speed or acceleration is, however, another story. For example, to attempt a 180° turn with a 10 mile radius of turn at 2,000 mph would subject the occupant to 4 g and a total duration of one minute. It is well established that the average g tolerance for the aircrew population is 5 g for five seconds. Fortunately, nature has been on our side in this regard, in that it is difficult to attain this speed at low altitudes as can be seen from the flight envelope. At the altitudes at which this speed is attainable, it is aerodynamically difficult to achieve a turn in this radius. However, prolonged exposure to low levels of g will be encountered for extended periods of time – several minutes – even in the most gentle manoeuvres. While this does not give rise to blackout effects, it hastens the onset of fatigue, and applies a further physiological stress to the occupant, as will be discussed later.

One of the principal effects of speed is the aerodynamic heating effect. The temperature rise at the skin of the aircraft above the ambient air temperature is directly proportional to the square of the true airspeed. This means that an aircraft travelling at 500 mph will experience a temperature rise at its skin of 45°F. An aircraft travelling at 1,000 mph will experience a temperature rise at its skin of 180°F. An aircraft travelling at 2,000 mph will experience a temperature rise at its skin of 720°F. You can well imagine what might happen to a human in an aircraft travelling at these higher speeds should the cabin temperature regulation system fail and allow the cabin temperature to approach these values. In the past, in keeping with scientific methods, each of the above mentioned problems has been considered an entity, and perhaps rightly so. But today, with the advent of high performance aircraft, physical stresses of low ambient pressure, pressure breathing, prolonged low accelerations and abnormal heat load, must be considered jointly with those mental and biochemical stresses which may have been present prior to flight, such as anxiety and low blood sugar. It is realized that such a program on combined stresses is not a simple one, but will require the efforts of a great number of people. Certain phases of such a program are under way at the Institute of Aviation Medicine.

ALTITUDE AND SPEED IN COMBINATION

We have dealt very briefly with problems arising from altitude and speed considerations alone. Now let us turn our attention to problems which require the consideration of both speed and altitude. The major problem in this respect is escape. The first achievement in this venture must be physical separation from the aircraft and, subsequently, clearance from collision with aircraft appendages. Below 200 knots, it has been demonstrated on many occasions that it is physically possible for an individual to remove himself from an aircraft. There have been instances at higher speeds. However, on examination of the flight envelope of the aircraft under consideration, it can be seen that the region below 200 knots represents a very small proportion of the useful flight envelope. The most successful method of ensuring escape from high performance aircraft to date is the ejection seat. This device is fired up a set of guide rails by an explosive charge, achieving sufficient velocity in the few feet available to ensure complete clearance from external aircraft structure. The early problems of preventing an injury during the acceleration phase of escape are solved. It was found that if the rate of application of acceleration up the guide rails did not exceed 300 g per second up to peak g's of the order of 20, and the total duration of acceleration did not exceed 0.2 seconds, no injury resulted to the properly positioned occupant. On achieving structural clearance, a whole new set of circumstances is encountered. The first of these is the force due to the moving airstream. This acting on unprotected and vulnerable parts of the body, such as the head and the limbs, may impose local tearing stresses to both the human and his vital equipment. In addition, this same force acts as a deterrent to further forward action and results in rather abrupt deceleration. The human tolerances to these abuses are becoming more clearly understood, principally from the fine work of Colonel John Stapp of the USAF and his rocket sled program. It is now considered that man can withstand windblast pressures of the order of 12 psi, and decelera-

tions of the order of 50 g peak, with rates of rise of 500 g per second for total durations of less than 0.2 seconds. If escape takes place above 10,000 ft, further insults are hurled — the danger of frostbite on descent and the opening shock of the parachute. Should an attempt be made to open a particular parachute at 40,000 ft, for example, an opening shock of approximately 33 g will be sustained by a 200 lb man. If the opening is delayed to levels of 20,000 ft, the opening shock is reduced to the order of 20 g. If it is further delayed to 10,000 ft, an opening shock of the order of 10 to 12 g may be expected. In every respect, then, the procedure after separation from the aircraft is to descend into the lower regions of the atmosphere as quickly as possible.

Before the introduction of fully automatic ejection seats, this procedure was carried out by the free fall method. Aircrew were instructed to separate immediately from their ejection seats by undoing their harnesses and to delay the opening of their parachutes until 10,000 ft was reached. The onus of judging this free fall was a heavy one. In recent years, this burden has been taken away from the man and completely automatic ejection seats have been introduced. After the decision has been made to eject in a fully automatic seat, the man has no further tasks to perform. He is automatically separated from the seat and his parachute is automatically deployed at the proper altitude.

There are two areas where research and development are still required in escape systems. These are at high speed and low altitude. The high speed difficulties arise from the aerodynamic forces encountered on entering the moving airstream. These forces may give rise to pressure and decelerations in excess of human tolerance and may cause structural failure to the man's protective and safety equipment, such as pressure suit and parachute. The upper limit of escape without injury in conventional ejection seats, with provisions made to restrain the limbs from flailing, would appear to be 550 knots indicated airspeed. Recent work by Stapp tends to indicate that this figure might be increased to 650 knots indicated airspeed under certain conditions. Beyond these values, it would appear that a stable, low drag enclosure in the form of a capsule, offers the best chance of escape. The development of capsule escape systems has been slowly progressing for many years in the United States, but within the past few months, the pace of development has been sharply accelerated. A possible interim solution to the high speed problem is to attempt to decelerate the aircraft prior to ejection by means of a braking device, such as a metal ribbon parachute. Time would not always be available to deploy such a device, but it is felt to be worthy of consideration.

At low altitudes, very little time is available to carry out the necessary ejection sequences. Precise and reliable timing devices are required to actuate the separation of the man from his seat and to deploy his parachute. This area of escape system development is rapidly reaching a successful conclusion, due to the fine work of Mr. James Martin of Martin-Baker Aircraft, England, who has on several occasions demonstrated live ejections from aircraft while still on the runway.

If escape is mandatory at low altitude and high speed, only a well planned compromise of escape sequence timing can be offered at present. Here, the development of the parachute must be delayed until the airspeed has fallen to a value which will not incur injury to the man or damage to the parachute canopy; yet this time may not be available, since a safe landing speed must be achieved prior to contact with the ground.

Higher ejection trajectories, without increasing ejection acceleration beyond human tolerance, appear to offer the best solution. These new trajectories can be achieved by rocket assistance, or by increasing the lift to drag ratio of the ejected system. Parachutes designed to exert lower opening forces at high speeds are also required.

CONCLUSION

The aeromedical problems associated with the operation of a high performance aircraft cannot be appreciated or solved by any one organization or scientific discipline, but require a frank interchange of knowledge and techniques between all disciplines and cooperation with many organizations.

THE SERVICING AND MAINTENANCE OF COMMERCIAL AIRCRAFT†

by R. J. Proctor*

Northwest Industries Limited

THE average commercial aircraft operator today finds it impractical to maintain the necessary experienced personnel, special equipment or accommodation to keep his aircraft in a fully operational state without some outside assistance. A number of servicing and maintenance companies exist to provide this prime function of assisting such operators to keep their aircraft in a serviceable condition.

The servicing of aircraft and the maintenance of aircraft are two different functions. "Servicing" includes refuelling, rectification of minor discrepancies (checking instruments that are malfunctioning, setting up brakes etc.) and many other items that can be accomplished as a one-stop service. "Maintenance" covers the complete maintenance and repair of the aircraft, including completion of operational checks or inspections, engine changes, structural repairs, completion of Certificates of Airworthiness, embodiment of CAA or DOT modifications and any other work required to keep the aircraft in a serviceable and airworthy condition, certified by the servicing and maintenance company.

The maintenance of aircraft today is somewhat different from maintenance as carried out in the past. It is not too long ago that maintenance of aircraft types, such as the Norseman, Fairchild, Bellanca etc., was carried out almost entirely in the open.

These aircraft operated mostly in northern Canada or other outlying districts where maintenance accommodation was extremely scarce or even nonexistent. This remoteness also made it necessary for aircraft to be operated mainly on skis or floats and maintenance had to be carried out on riverbanks or lakes and, in the winter, on snow covered strips.

Such conditions make maintenance somewhat difficult, especially should an engine change be required. Protection from the cold was often only a tarpaulin draped over a makeshift structure heated by a blow pot which produces very little heat. Any other repairs or inspection had to be completed in the open. Under these conditions there is much possibility for human error.

Today, outside maintenance is still being accomplished but with some improvements, such as nose hangars, Herman Nelson heaters etc.

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With the construction of airfields in some of these areas, larger and heavier aircraft are becoming more prominent in the commercial field. Outside maintenance of these aircraft is far from satisfactory since more and heavier equipment is required to carry out complete maintenance.

Very rapidly the operators of large aircraft began to require assistance and alleviation from the hazards and problems of outside maintenance. Various companies (such as Northwest Industries), who had been carrying out repairs, overhauls and conversions on the larger aircraft types for the RCAF, recognized this need of the commercial operator for maintenance facilities. They accumulated the necessary equipment, accommodations and personnel to carry out such servicing and maintenance to ensure that fully serviceable aircraft could be kept available to the operator.

On inspections, many items, especially on the larger aircraft, cannot be completed in the open and thus would have to be left due to lack of proper equipment or extreme weather conditions. One example would be an operational check of undercarriage retraction where weather conditions (surface and winds) would prevent the aircraft from being placed on jacks with any degree of safety. There are other items where a visual inspection is not sufficient and special equipment is required (e.g. magnafluxing the sway braces on a C-46, dye checking control columns etc.). It is possible for such items to appear serviceable to both operator and mechanic and still be in an unairworthy condition and lead to dangerous mishaps or at least costly repairs. Some such rectifications require a considerable amount of other work including sheet metal repairs which in many cases could be of a structural nature. There are many items which fall in such categories and prevent a complete inspection from being carried out where facilities and equipment are inadequate. Such facilities are available and when they are used the unknown factors can be eliminated.

Additionally, the delaying of inspection items frequently leads to a condition of considerable controversy between the operator and the maintenance company. When an aircraft is eventually brought in for clearance of these delayed items, often a complete No. 3 or No. 4 check is required. On the average, a normal No. 3 or No. 4 check will require 3 or 4 days to complete, but when there are a number of deferred items and associated rectifications, the time required is greatly in-

creased. In such cases, the operator feels that the aircraft is being tied up longer than he anticipated and considers that the maintenance company is taking much longer than necessary. The point that is often overlooked is that certain work has been deferred and rectification necessary which could not have been accomplished during outside maintenance; in fact any unscheduled work is time consuming.

To alleviate this problem, the maintenance company usually requests that the operator have a representative present when checks (or other work) are carried out in order that progress of the aircraft and reasons for any delays will be known, and appreciated, at all times.

Cleaning the aircraft is another item which cannot be done outside during winter. Although this may not seem too detrimental to the operation of the aircraft, dirt and exhaust cause corrosion which in time can be very dangerous and eventually costly. This item, plus the many others that cannot be completed satisfactorily by outside maintenance, indicate the advisability of having No. 3 and No. 4 checks, including engine changes, carried out by a servicing and maintenance company where experienced personnel, adequate equipment and suitable accommodation are all available.

To highlight the use of the servicing and maintenance company, last year an operator, flying out of Churchill, directed that all No. 3 and No. 4 checks, including engine changes, were to be carried out where facilities were available. This operator considered it impossible to do satisfactory outside maintenance due to the extreme cold weather. The expense of ferrying the aircraft to such a facility was more than compensated for by having proper maintenance and being able to continue flying with no major delays.

So far, the details given have dealt with reasons why outside maintenance is not too beneficial for the operator. There are, however, other aspects of a servicing and maintenance company.

In addition to the facilities to service and maintain aircraft, such companies are equipped to carry out all types of repairs, conversions and overhauls including the overhaul and repair of all components (undercarriage, control surfaces, wings, radio equipment, instruments etc.) and have the facilities to carry out magnafluxing, sandblasting, cadmium plating, manufacture of cables and other work required to keep aircraft airworthy.

Other services are very necessary, such as an approved aeronautical engineering department (required in developing suitable structural repairs and conversions), a complete inspection department, licensed personnel approved by DOT etc., in order to enable the company to carry out any type of work that may be required by the operators.

Another subsidiary phase of work carried out by such a company is the salvage of damaged aircraft, whereby personnel can effect temporary or complete repairs as may be required to ferry the aircraft.

It is certainly beneficial for an operator to have his maintenance carried out by a company with adequate facilities, as above, thereby keeping his aircraft in a serviceable condition at all times, eliminating deferment of inspection items, lessening the elapsed time required for inspections and, at the same time, being ensured of continued and safe flying.

Northwest Industries Limited is one of the servicing and maintenance companies providing these services and offering all the facilities outlined.

RELIABILITY CONTROL OF ELECTRONIC EQUIPMENT IN AIRCRAFT AND WEAPON SYSTEMS: GENERAL AND MANAGEMENT ASPECTS†

by C. I. Soucy*

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INTRODUCTION

THE problems involved in reliability control of electronic equipment, even when narrowed chiefly to the management aspects in the field of military aircraft and weapon systems, are complex. It is difficult, in a paper such as this, to give more than the illumination of a few selected highlights.

Many of the points emphasized in this paper have received general recognition in the recommended general studies, including that by the late Dr. R. Carhart[1] and a few others referenced in a previous paper by the author[2], as well as in other narrower treatments[3] where the vital facts of reliability control are often too much submerged in obscuring detail or have not been emphasized enough[4] to overcome established prejudices.

NEED FOR MANAGEMENT DECISION

Mr. L. M. Clement, a prominent advocate of reliability control, has affirmed in many addresses on reliability[5] the philosophy that the attainment of the reliability goal requires chiefly a new way of thinking and is a problem of vital concern for management. He quotes as proof of this point the performance of four manufacturers in producing a magnetron tube to the same military specification and test requirements. Average life figures were 1500, 500, 50, and 10 hours for the four different products, with the best produced by a concern which, guided by a determined policy, spared no effort in control and achieved a uniform, reliable product with reduced scrap loss and total cost as well. To some, the disparity between present equipment performance and desired goals may seem hopeless but, if the military users will realize and evaluate their needs quantitatively and demand firmly that they must be met, the design engineers and—given adequate incentive and fair contractual procedures—industry will follow through with adequate solutions.

Military management and budget planners need have no scepticism about the proven results of reliability programs and justification of the expense and effort involved. U.S. Department of Defense figures show that in new airborne and shipborne radar sets reliability improvements as great as 100 to 1 compared with average current performance have been attained[6]. From the military management point of view, we are concerned with much more than the operational deficiencies of equipment. These are of vital importance to our success in defence, but their tactical consequences are extremely difficult to evaluate. In addition to these, we are faced with both disastrous shortages of maintenance personnel and excessive maintenance costs, unless existing rates of failure are very greatly reduced. A spokesman for the Department of National Defence, Mr. M. L. Card, at the recent Institute of Radio Engineers convention in Toronto, presented an invitation to industry to cooperate in this defence crusade and to devote adequate effort to understanding and remedying our troubles.

To sponsor and direct a remedial program, the management of both industry and the military require an understanding of the factors that control reliability. These have been explored more fully in a previous paper[2] and will be reviewed only briefly here to present a balanced perspective.

ECONOMICS OF RELIABILITY CONTROL

You have probably heard that about one third of the electronic equipment produced during World War II, which was transported to dependent users all over the globe at high cost (billions of dollars for the Allied forces), proved useless and wasted millions of man-hours of effort. This deplorable loss was due to built-in unreliability. The economic worth of achieving reliability is more clearly obvious for operating communciation companies and airlines who can measure it by profit margins. Aborted military aircraft missions cannot be evaluated merely in financial costs, although this appears as a noteworthy figure in the case of huge bombers, such as the B-52 reported to cost $10,000 per hour to fly. If failure of navigational instruments or protective fire-control systems cause destruction of the aircraft, this amounts to $8 million (without counting crew training and replacement costs) for the B-52.

Airline yearly maintenance costs for electronic equipment have been reported as 30% of the initial capital cost, whereas the Rand study[1] made for the USAF indicated an average yearly maintenance cost of double the initial equipment cost. Perhaps an example will make the economy of reliable equipment clear. Let us suppose

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†Abbreviated version of paper presented to the Ottawa, Cold Lake and Edmonton Branches on the 13th February, 21st March, and 22nd March, 1957, respectively.

*Air Materiel Command

that a contract choice between two competing equipments *A* and *B* (a more reliable design) involves the following costs:

	A	*B*
Development	$ 1 million	$ 2 million
Production	10 million	12 million
Maintenance (5 years)	110 million	55 million
	—	—
Totals	121 million	68 million

Savings $53 million

If such a saving in maintenance due to lower failure rates is doubted without proof, consider that a mere 3% reduction in maintenance cost (*A*) would pay for the increased development and production costs of the more reliable equipment.

The paramount requirement for reliability in equipment may conflict with requirements for other physical or performance characteristics, especially in airborne use. The demand for accuracy leads to complexity with effects on reliability in inverse proportion. Moreover, the trend towards miniaturizing to save space and weight has initially been detrimental to reliability, due especially to higher internal equipment temperatures. That we are learning to compensate for such effects is demonstrated in recent airborne radio sets, in which size and weight have been reduced 2 and 3 to 1 respectively (without employing transistors) and with a gain in reliability. Sealing of airborne equipment also is likely to result in an increased weight and size penalty of 10 to 15%, but gains in reliability (of up to 8 to 1 in British TRE tests[7]), provided internal equipment temperature is not raised, will usually justify this small detriment.

We must be prepared to pay more for the greater development effort involved in designing reliable equipment, up to 2 to 3 times for airborne equipment according to one recent estimate[7]. Usually the production costs for equipment will be increased as reliability is improved, since reliability control provisions will cost in the order of 15% of production costs and 25% of research and development costs for complex equipment, such as guided missiles, for which reliability control staffs of twenty to thirty persons may be required, according to Dr. L. W. Ball's statement to the 1956 Guided Missile Reliability Symposium.

COMPLEXITY AND TIME FACTORS

Component parts usually act like links in a chain which fails when any component link fails. Therefore, failures tend to vary directly, and reliability inversely, with complexity. Despite this accepted fact, there is still a tendency in military circles to ignore the complexity factor in setting up arbitrary reliability requirements based only on what is operationally desirable[8, 9].

For an equipment with 1000 components, having an individual part reliability of 99%, the overall reliability is unfortunately not the average but the product, that is, 0.99 multiplied by itself 1000 times, which is only 0.00004 or 0.004%. Even for the lesser complexity of 100 parts, having an individual reliability of 99%, the overall figure is only 36.5. If the component reliability is raised from 99 to 99.9% (i.e. failures reduced 10 to 1 in ratio or from 10 to 1 in 1000), the reliability of a 400-part equipment will be raised from 2 to 69%.

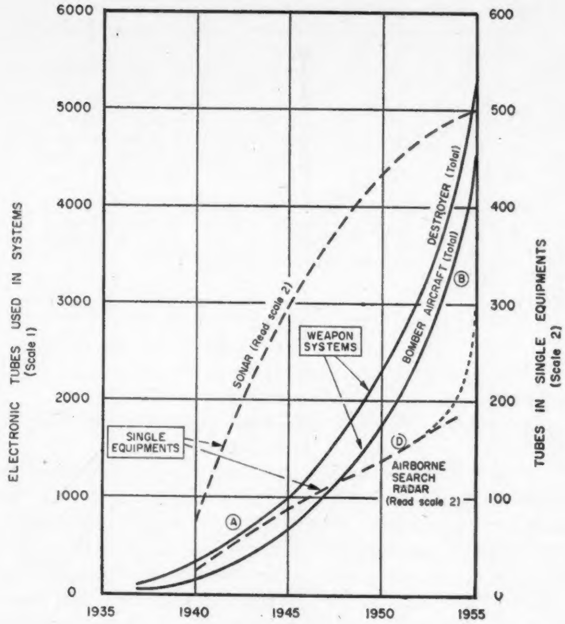

Figure 1
Increasing complexity of military electronic equipment and weapon systems measured by tubes in use

There is a constant tendency for complexity to increase because of military demands for greater precision and due to the call in airlines for additional safety provisions. Figure 1 shows that there is at present no indication of slackening in the increasing number of tubes and components in a typical weapon system. Although the rate of increase in complexity may be tapering off for most individual equipments (shown in the sonar equipment example), this tendency may change, as in the case of the airborne search radar, because additional functions are added, such as a computer; also, and most important to note, the tendency towards stabilization of equipment complexity is outweighed by the multiplication of equipments needed in the system to perform additional functions. We must face the fact therefore that, due to the increasing deficit[10] between the large increase in complexity and relatively small improvement ratio for tubes and components (about 2 to 1), the reliability of complex systems is only about one tenth of that of the simpler systems of 15 years ago. It should be stressed that our major military problem is not, as is sometimes urged, that of making equipment simpler—desirable though this obviously is—but, more realistically, it is that of making necessarily complex equipment reliable as well as simple to operate and maintain.

The validity of the assumption that the failures of heterogeneous parts of mixed ages and conditions and also failures of complete equipment occur randomly in military use, and that these failures follow an exponential relation with time has been proven[1, 3]. Figure 2 depicts in a simple graph with a linear scale the performance of a typical fire-control system designed a few years ago. This tapering exponential decline (approximately linear up to the mean-time-to-failure) of the probability of mission success or reliability with respect to time is

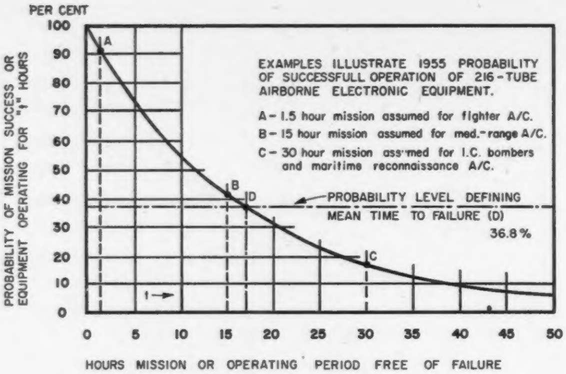

Figure 2

Operational mission performance (reliability) vs time

not an obvious one either to operational planners or to most electronic specialists, conditioned as they are by everyday experience with the "wear-out" failure characteristics of automobiles, aircraft engines and incandescent lamps. Actually only 4% of electronic components replaced fail because of normal wear-out—a fact that has been sadly neglected. We may also note that for the less than one tube in four that remains in use long enough to be removed because of deterioration of emission[3], a large proportion suffer this fault due to design misapplications.

Figure 3, which, like Figure 2, is intended for operational planners, extends the time scale in a semi-logarithmic chart and allows us to examine the effects of complexity and the state-of-the-art design level for the military aircraft environment. The three aircraft designations shown, fighter, interceptor and strategic or reconnaissance bomber, refer to complexity levels specified in Figure 4 and do not define actual aircraft categories. The dotted lines through A, C and E similarly label three arbitrary mission times. It is seen that the complexity level of the fighter aircraft results, at present, in good reliability only for one short mission period and that reliability improvements of 25 and 100 to 1 are desirable for acceptable reliability at longer mission periods for the two larger aircraft considered.

CRITICAL COMPLEXITY, RELIABILITY BARRIERS AND ADEQUACY OF IMPROVEMENT GOALS

Few reliability discussions have presented the concept of critical complexity and reliability barriers. Both operational planners and equipment designers should be familiar with these and their relation to:

(a) the time of mission or operation,
(b) the reliability of component parts in the environment of usage,
(c) the skill factor involved in overall system design, and
(d) the completeness of development (up to the reliability barrier).

Figure 4 (based on data in Table 1 of Reference 2) is presented to show the relationship between critical complexity, mission period and any required reliability for the 1955 design level and for design levels of desired improvement reducing failure rates 25 and 100 to 1 respectively, corresponding to the modest RCAF goal and more optimistic USAF (Scheer[8]) goal. (It should be noted that definition of these two goals in numerical ratio of improvement represent the author's evaluation and is not officially recognized by the Services concerned.) Unless the design and part reliability are improved, it is apparent that the critical complexity must not be exceeded if the mission time and per cent reliability are prescribed, or if, as usual in past common practice, the complexity and mission time are determined by operational requirements, then the remaining factor of the reliability attainable is indicated. It may be noted that a level of complexity may be critical not only with respect to a desired reliability as shown in the chart but also with respect to the maintenance capability of the user.

The centre portion of the figure illustrates the 90% reliability goal (at point D) for a 200-hour operating period required in an RCAF specification for a UHF set initially expected to have about 45 tubes. This reliability figure corresponds to a mean equipment life between failures of 2000 hours. Even the 100 to 1 improvement goal will not result in adequate reliability (point E) at the complexity level of a large strategic bomber, if operation of all equipment were vital (a pessimistic assumption) during a 30-hour mission without maintenance. The inadequacy of both present and proposed future reliability levels for the three aircraft complexity levels can be observed more clearly from Figure 3, which is confined to this simpler comparison. It can now be reported that half of the USAF 100 to 1 improvement goal has been attained in a Hughes Aircraft Co. airborne set[2]. However, unless increasing operational necessities and the complexity trend illustrated in Figure 1 are arrested, the goals that seem adequate at present will soon be superseded.

For a complex missile system, several years may elapse before appreciable reliability is reached. For large and small systems, there is an apparent "reliability barrier" at which further improvement stagnates. Lusser and Pieruschka attribute this to the limited skill level of

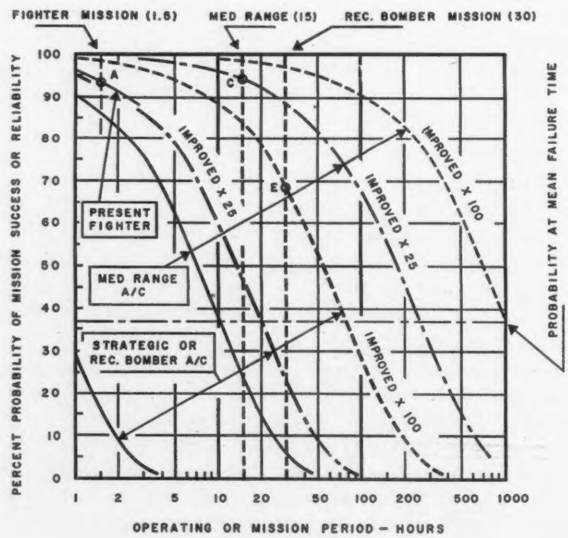

Figure 3

Variation of mission success vs time, aircraft complexity and design level

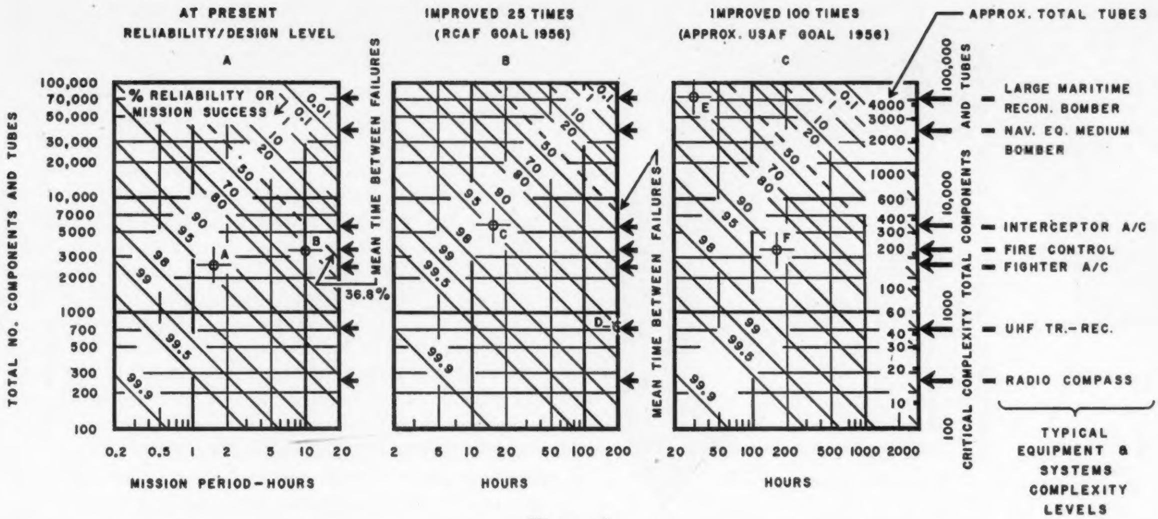

Figure 4

Critical equipment and system complexity vs mission period and reliability requirements, based on present and future improved design levels for airborne electronic equipment

the contractor and employment of obsolete reliability concepts, together with insufficiency of reliability funds and effort applied by the military[10].

EVALUATION OF RELIABILITY

Failure rates and mean-times-to-failure are convenient ways of measuring reliability, particularly for tubes and component parts. This method has its drawback, in the case of complete equipment and systems, and is quite unsuited to one-shot guided missiles, in which the short operating time is not significant in determining reliability in the form of kill probability. The prevalent uncritical use of mean-time-to-failure has led to some erroneous conclusions. Obviously, for equipment other than missiles, our practical need is to minimize the time that equipment is not fully available for its intended use. Thus, it is often of equal or of even greater importance than the failure *rate* to minimize the proportion of the desired operating *time* during which performance is cut off or deteriorated below acceptable levels.

It is of vital importance that the advocates of concentrating remedial effort on improvements of tubes and components realize that equipment and system reliability is not merely a matter of minimizing failures, but also involves increasing the efficiency with which the existence of failures is recognized, their causes determined and localized, and appropriate corrective maintenance action taken, all for the purpose of minimizing down-time.

The less dramatic but more prevalent problem of malfunctions caused by gradual deterioration of parts and adjustments has generally been ignored in comparison with catastrophic failures. However, this type of fault warrants both increased attention in design and more effective performance-monitoring techniques in operation and maintenance. The U.S. Navy data indicating two-thirds of equipment operating below par[1] is probably typical. In proving tests of Tacan equipment in 1956, an unusually high percentage of failures—50%—was found to be associated with adjustments.

The efficiency of the logistics organization in providing spare parts to meet replacement needs without delay and in providing adequately skilled maintenance often becomes the most neglected factor. On the other hand, while the designer can affect maintenance requirements through his packaging design and use of parts of adequate reliability and while he should consider and understand the difficulties involved in military maintenance, he cannot be made responsible for faults in the military logistics organization and maintenance planning.

For most airborne equipment during flight, one-shot guided missiles and for unattended ground equipment, maintenance is not available during operating periods. In such cases, down-time and the expenditure of special design effort to decrease down-time, by simplifying maintenance and facilitating testing and replacement, may be of less importance than simple minimization of failures. Airlines employ redundancy in the form of standby electronic equipment, but only recently in the largest military aircraft has the need for in-flight maintenance been provided for. Considering the higher failure rates of airborne equipment and the closely comparable system complexity of large bombers and naval destroyers, as shown in Figure 1, there is a startling contrast in maintenance provisions. For a naval destroyer, having equipment using a total of 3200 tubes in 1952, the services of 14 technicians were provided to take care of peak maintenance loads (estimated as ten times the average load) over long mission periods away from base[1, 4, 11].

ANALYSIS OF CLAIMS RE FAILURE CAUSES

The inadequate failure reporting on military electronic equipment in the past, which the RCAF is now improving rapidly, when supplemented heavily by the results of well-known United States studies[1, 2, 12], makes possible an analysis of the ideas and misconceptions commonly held about the causes of failures. A correct understanding of the basic facts is essential to both the management of military and other large-scale equipment users and to equipment designers who require guidance in design improvement.

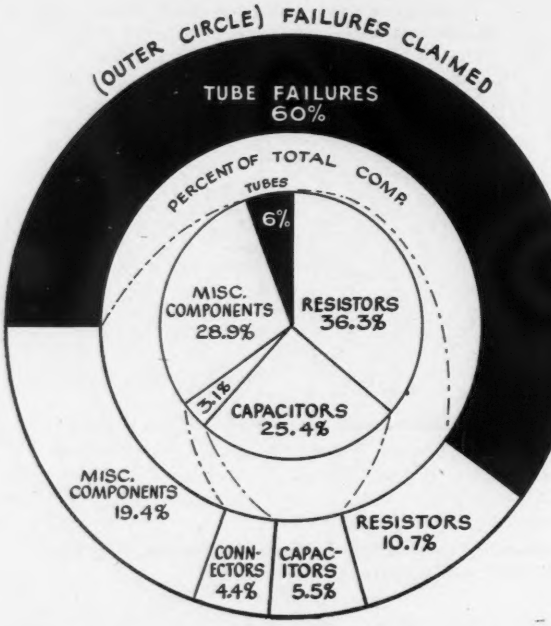

Figure 5
Relation of equipment failures attributed to tubes and components and percentages of use

Figure 5, which portrays both failure and population percentages, is reproduced from a previous paper by this author which provided more technical detail on this subject[2]. It is unique among analyses of failure claims only in presenting combined tube and component failure data. Through an analysis of the failure causes (which is not reproduced here from the reference given) the final breakdown of control factors indicated in Figure 6 has been deduced and, happily, has recently been confirmed in its general proportions by the more exact engineering studies of two of the leading U.S. designers and manufacturers of military electronic equipment. It shows roughly equal control *at present* ascribed (for *all* types of military equipment averaged together) to overall equipment design, operating/maintenance practices and to the design adequacy and manufactured quality of component parts and tubes.

It can be shown that not only are the present tubes and component parts not reliable enough to meet the demands for complex electronic equipment[2] but the military specifications for them do not prescribe high enough requirements; do not provide failure rate data necessary for predictability of performance; and do not require the testing to failure that is necessary to establish safety factors and margins and to measure the variability of the product.

OPERATING/MAINTENANCE ENVIRONMENT AND USAGE FACTOR

Much attention has been given to the obvious effects of measurable physical conditions in military usage of electronic equipment exposed to critical environments including airborne use. As a result, military specifications include tests intended to assure compatibility of equipment design with such environments. Appreciation of the effects of the less readily defined and measured operating/maintenance environment imposed by military personnel is much more lacking.

ARINC studies[3] of tube failures in military bases show how the tube removal rate varies between bases, how the initial failure rates are increased in air stations, and how all have much higher tube replacement rates than airlines. Such studies also show conclusively that the frequency and even the nature of the equipment failures are less characteristic of the equipment, tubes and parts than of the military base on which they are used [2, 3]. Another comparison based on ARINC and other sources[1, 3, 12] is presented in Figure 7, which is a simplified operational type chart showing the variation in equipment and system failure frequency with the usage environment as well as with complexity. It is admitted that the contrasts of military failure rates with rates applicable to commercial communications, with the superlatively reliable trans-Atlantic telephone cable system (with a goal 770,000 times better than the performance of poorly maintained military airborne equipment) and with airline equipment of equal complexity and rather similar quality of parts are not fair direct comparisons. However, it is hoped that such contrasts will prove thought-provoking and demonstrate clearly that *good commercial equipment is not good military equipment* even with high-quality or military grade tubes and components.

Military equipment life-time requirements differ from those of airlines. In airline use, at 3000 or more flying hours per year, where aircraft flying lives of 50,000 hours are expected, equipment would not be considered expendable at 2000 hours, as it is by Geo. H. Scheer[8] for USAF use with an aircraft utilization rate of 300 hours per year.

The poor performance of airborne military electronic equipment is no longer defensible or tolerable, but to keep its reputation within proper perspective it is only fair to report that, in many military aircraft, failures

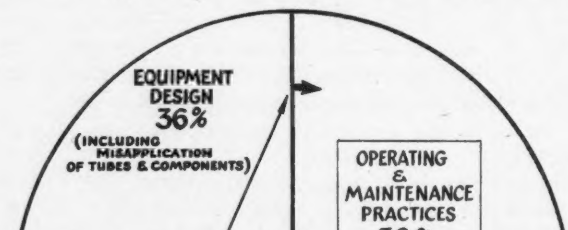

Figure 6
Rough analysis of control factors for failures generally in military electronic equipment

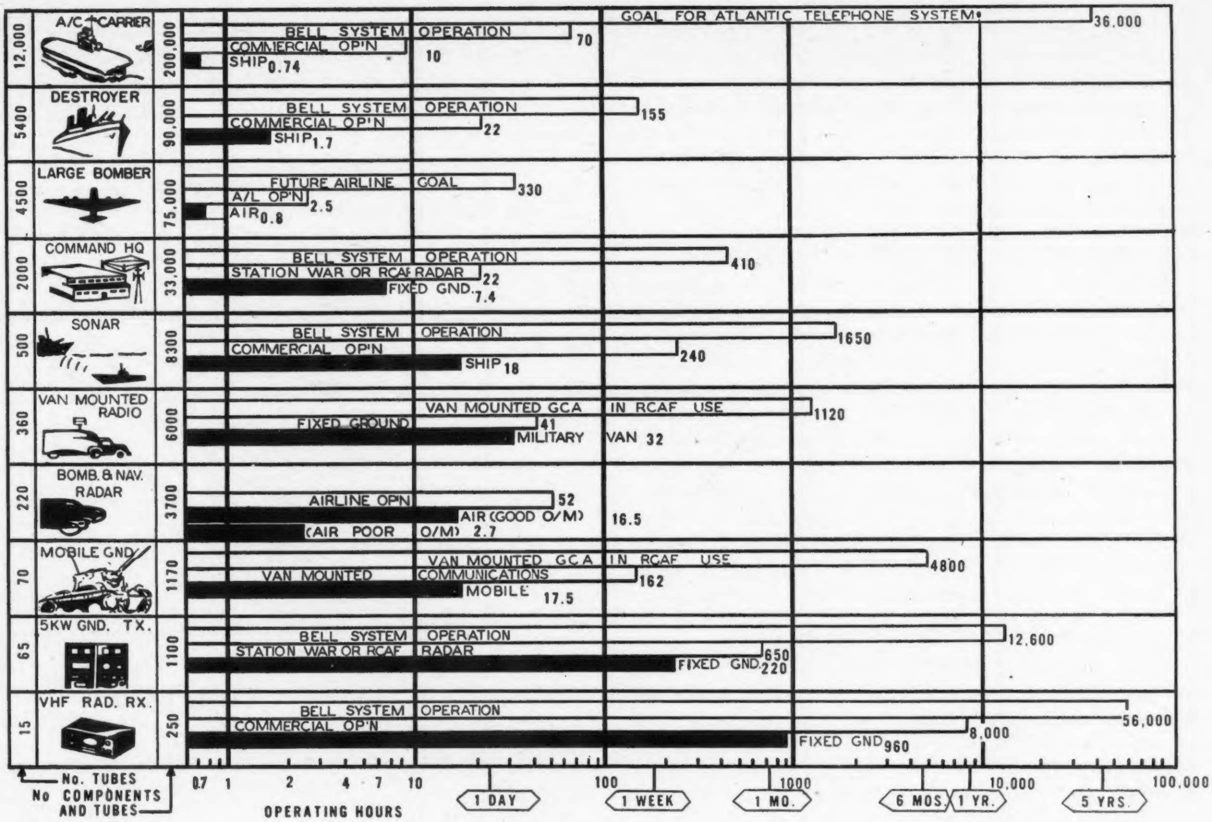

Figure 7

Failure-free operating time for various classes of military equipment as determined by complexity and operating/maintenance usage with comparisons to commercial and airline equipment performance

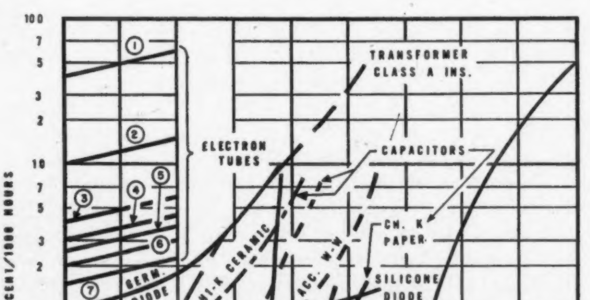

Figure 8

Failure rate variation vs ambient temperature at normal rating

in the electrical system, airframe, navigational and flight instruments are of comparable magnitude, while those of engines are 2 to 3 times less than for all telecommunications equipment.

In guided missiles, electronic parts have a higher failure responsibility amounting to 60% compared with 30% for propulsion, 7% for booster and 3% for hydraulics.

DESTRUCTIVE PHYSICAL ENVIRONMENTS

Operational users and management personnel need to have a general appreciation of the destructive effects of the physical environment, particularly with respect to the important but previously neglected factors of tube heater over-voltage[2] and internal heating of equipment.

A general figure of a 2 to 1 reduction in part life for a 20°C increase in temperature has been quoted in several papers. Figure 8 (based on recent RCA data[13]) shows how the rate of deterioration is lesser or greater for some parts and tubes. It is seen to be unfortunately true that few parts fail to reach disastrous failure rates at temperatures between 90° and 130° (when used at full rating). Even in airlines, tube failure rates apparently vary 3 to 1 due to operating temperature differences in different aircraft of the same airline[7].

The astounding reductions in tube operating temperature, up to 100°C below bare bulb temperature, and

consequent reductions in tube failure rates that have been demonstrated in the use of improved tube shields lead one to wonder whether designers are as blind to obvious needs and defects of existing design practices as automobile designers were for decades before acting on the obvious need for protective bumpers. Some standard military tube shields[11] have raised normal tube temperatures by 60°C and yet they were never considered as thermal blankets!

OPERATING AND MAINTENANCE IMPROVEMENT

The Figure 6 analysis of control factors indicated a substantial one-third control of failures and malfunctions by operation/maintenance practices. Management in industry would expect, on the basis of its experience in this field, that this would be a promising area for improvement effort; however, the gains in efficiency in the communications industry and airlines are more difficult, if not impossible, of attainment in the Armed Services due to shifting personnel, lack of specialization, policy and human factors that yet need special study. However, the RCAF has demonstrated 2 to 1 failure reductions in airborne equipment and 4 or 5 to 1 on fixed radar stations within short periods of time.

BASIC NEED IS BETTER (MATURE) DESIGN

If the analysis of reliability control factors shown previously in Figure 6 be valid, it is evident that even large presently feasible improvements in the durability and reliability of tubes and components are not the answer to the problem of attaining up to 100 or even 1000 to 1 improvements in system reliability for the most complex aircraft and weapons systems.

Only a small part of the potential benefit from improvements in the intrinsic reliability of parts that is resulting from the present programs for improving tubes and components (whose value is in no way depreciated) can be realized until the present weaknesses in system and equipment design and their present dependence on operating/maintenance procedures are eradicated. This is not yet commonly recognized and is contrary to many published statements[8] leading to false hopes, for example, of duplicating the airlines benefits from the use of improved tubes[3].

Put in another way, the problem in system and equipment design, apart from use of better parts where available, and simplification to reduce the number of critical parts and tubes required, is to make the equipment more impervious to the unavoidable but usually ignored deterioration of tubes and components with use and more impervious to the effects of "finger trouble" and limited capabilities of human operators and maintainers in the military environment. To appreciate the latter point, designers should have the opportunity to see equipment and personnel under working conditions as a normal contract privilege. Just recently the USAF has started a program to provide such familiarization.

It is not practicable, desirable though it would be, to cover the wide field of improved design techniques, application of human engineering and system design integrated with the capabilities of operating and maintenance personnel, which have received considerable attention in technical papers[14] during the past few years and in reliability design handbooks[11, 15, 16].

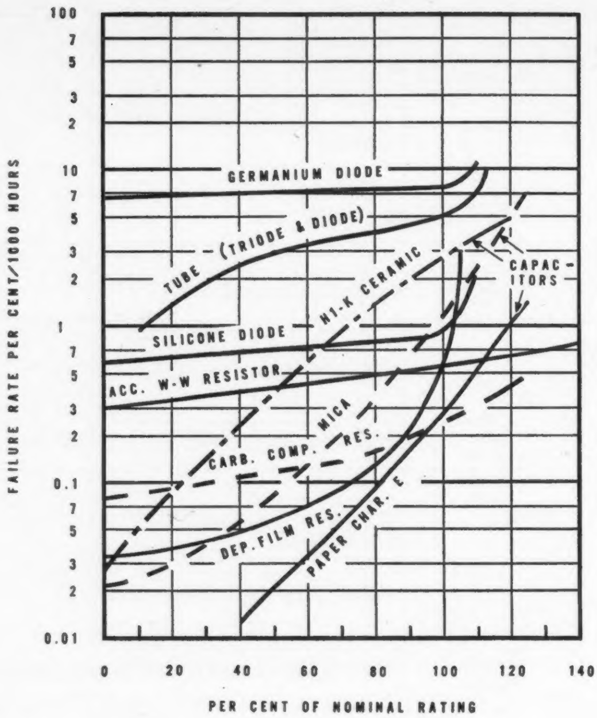

Figure 9
Failure rate variation vs derating at 90°C ambient temperature

A recent program, whose object is the standardizing of basic electronic circuits to eliminate the constant changes in them from equipment to equipment and in the parts and tubes employed, promises to help counteract the design immaturity partly and to avoid the repetition of old errors by new designers of insufficient experience[11]. Use of standard circuitry will make it less necessary to employ genius effort of the "radio ham" variety in the usual chaos of "debugging" as an alternative to initial good engineering design. The extent of "modification engineering" as currently carried out is indicated by two examples: (1) in the AN/ARC-27 airborne UHF set, 100 modifications have been applied; (2) for some guided missiles, over 2300 field changes have been made. It should be obvious to all concerned, from many past examples, that the costs and delays involved in factory and field conversions far exceed those required for a mature engineering job in the development stage.

A recent RCA estimate[17] on the amount of extra development necessary to assure a reliable design is of interest. For each "complexity unit" of 25 tubes, transistors, or relays (corresponding to a component total of approximately 360) one senior engineer man-month of work was quoted.

Figure 9 based on RCA data[13] shows the varying effect of derating on various components operated at a fairly high ambient temperature. The earlier idea of a "safe" derating factor to avoid a critical operating condition needs correction, since it may be observed that reliability generally continues to improve as derating is increased. Since we have been unwisely pushing components to their critical failure limits of rating and

TABLE 1

EXAMPLES OF INCREASED RELIABILITY DUE TO IMPROVED EQUIPMENT DESIGN OR OTHER CHANGES

Equipment, Part or System	Change	Reduction Effected (Actual or Estimated)				References
		No. of Parts & Tubes	Controls	Failure Rate	Fault Location & Maintenance Time	
Design						
Ship Radio Transmitter	Circuit Simplification	35 tubes (from 92) 60 relays			5:1 in downtime	9, 11
Sonar	Circuit Simplification	61 tubes, 8 sw etc.	22 to 6		10:1	9, 11
Ship Radar	Circuit Simplification	Tubes and Parts	22 to 10 with 7:1 better adjustment accuracy			9, 11
Collins 618A Transceiver	Unitized packaging, improved cooling etc.			7.3:1 in USAF test		Aviation Week Jun '55
Radio Terminal Eq.	Blowers added to Equipment "A"			2:1		12
Ship Radar	Layout only changed to minimize maintenance			Failure recognition 4:1	Failure location 3:1 Diagnosis errors 15:1	4, 11
C. Composition Resistors	Derated to ¼ rated power			10:1		8
Paper Capacitors	Derated to ¼ rated volts			15:5:1		8
Receiving Tubes	Derated to ¼ in power			3:1		8
Miniature Tubes	Replacement JAN tube shields with heat-reducing type	Bulb temperature reduced by 60 to 120°C		Est'd 2 to 5:1		11
Maintenance						
Fixed Ground Radar	Minimized-Maintenance Program	Replacement tubes and parts 6:1		Availability increased from 70 to 95% (some 99.9%)		RCAF

temperature, where differences in failure rates are seen to be only of the order of 10 to 1, it is significant to note that, in more conservative design practice, these increased differences may rise to a ratio of 1000 to 1.

Table 1 (from a previous paper[2]) also gives several examples of increased reliability effected by improved circuit design, packaging, use of better parts or greater derating and by means of minimized maintenance practices.

SPECIFYING AND PREDICTING RELIABILITY

The initial step needed for military management in a coordinated reliability control program is for the operational planners to evaluate the operational requirements for aircraft and weapon systems and to ensure that these are expressed in military characteristics formulated by them and in the equipment specifications based thereon produced by the design authority.

Specifications for reliability become practicable if the equipment designer can predict the failure performance[1, 5]. This subject is too technical for further discussion here. It can be reported that progress is being made at an encouraging rate in developing the much-needed capability of predicting reliability in the design stage[7, 13, 14, 17, 18]. Not only have recent VITRO and ARINC studies resulted in close agreement of predicted and actual results, but agreement to within 5% in the guided missile field has been claimed by Sandia Corporation, and recent RCA claims cover a 20% agreement in the general electronics field[17].

MILITARY VS AIRLINE APPROACH TO DESIGN

Many features of the airlines' approach to the design of electronic equipment are worthy of consideration by military users and, similarly, the airlines will find it useful to learn the new military reliability control techniques. Equipment designers in industry must understand both viewpoints and apply them to the best advantage. In an illuminating study of these two approaches and commentary on the ARINC Report on "*Guidance for Designers of Electronic Equipment*", Poritsky[19] has pointed out that the freer exchange of views between designers and airline users would benefit military services who are frequently too positive that they have prescribed theirs with perfect clarity in rigid specifications.

OTHER FACTORS AFFECTING EQUIPMENT RELIABILITY

Engineering management needs to become aware of deficiencies and lack of engineering maturity in the common approach to the design of military electronic equipment. The new "life-or-death" approach[10] and its relation to safety margins, advocated by Dr. R. Lusser for guided missile designers, are vital for any complex military or airline electronic equipment design.

Many recent technical papers have attested to the importance of adequate laboratory and factory testing

and statistical quality control in reliability control programs. It seems advisable to point out there are some practical and economic limitations of statistical testing methods, used in both production quality control and laboratory acceptance tests, which are not always realized or acknowledged by the specialist advocates. Such methods are inadequate in determining and assuring reliabilities of 1 part in 10,000 or 100,000 required in complex missiles and other electronic devices. In such cases, mature engineering judgment and use of tests to destruction, to eliminate areas of weakness and attain high safety margins, are practicable and economical procedures. The chief management problem of the equipment producer and designer in this sphere is to advise an error-detection system which, by means of audits at key stages of the processing, will ferret out those human errors in the design and manufacturing processes that are responsible for most failures in use other than those caused by operating and maintenance personnel. Fortunately, this control can be achieved through laboratory testing[20].

In the field of guided missile development, management is becoming aware of the utility and necessity of employing tests to destruction. Instead of involving an increased new expense which delays development, its proponents claim that it is only about one tenth as costly as flight testing and produces the necessary design data early enough to be effective in guiding changes to improve reliability and performance. One outspoken critic of the fantastically costly practice of flight testing guided missiles to correct design faults and raise reliability to tolerable levels claimed at a recent symposium that all that these expensive tests proved was that "the law of gravity still functions". In other electronics fields the appreciation by management of the value of tests to destruction and their overall economy is just awakening[14, 20].

THE PROCUREMENT BOTTLENECK

No survey of the reliability problem would be complete or realistic without recognizing, as serious critics in industry[5] and the Armed Services have done, both the bottleneck to attainment of reliability often imposed by procurement policies and practices and the need of incentives for the attainment of reliability in design and production, by making this result more profitable instead of less so to competent manufacturers.

Mr. J. M. Bridges, Director of Electronics in the office of the Assistant Secretary of Defense (Engineering), Washington, D.C., has pointed out[6]:

> "Even if we can obtain the objective of excellent design, thoroughly proven as to performance, reliability, and producability, we can lose much of this inherent quality by indiscriminate selection of development and production contractors on the basis of cost alone. We must rely upon the producing contractor to maintain the quality of reliability inherent in the design. The reputation of the contractor to produce quality must be given careful consideration in selecting him for a contractor".

The U.S. Department of Defense has incorporated new procurement policies, such as those expressed by Mr. Bridges, in directives such as No. 4105.10 which requires that price alone shall not prevent placing an initial production contract with the concern who carried out the equipment development. Such concerns have frequently lost on bids for production because their estimates were based on a realistic knowledge of the problems including the cost of attaining reliable performance.

It is here urged that we do not content ourselves with adopting a rational scientific approach only toward operational requirements and reliability engineering control and fail to appreciate the need for realistic thinking on procurement methods and in considering overall economy in the use of Defence funds, weapons and manpower.

RELIABILITY ORGANIZATION: MANAGEMENT PROGRAM OBJECTIVES

The general lines for the technical solution of our present reliability dilemma are known and are being put into practice by several organizations that are well advanced in reliability engineering. The need for military-industry understanding and cooperation has been stated by Mr. Bridges[2]:

> ". . . regardless of how clearly design engineers understand the values of these (design) factors and the means for accomplishing them, they cannot apply their knowledge without the assistance of proper program objectives and guidelines and the full support and understanding of management.
>
> ". . . In the past there has been a tendency on the part of military people to lay most of the blame for unreliability on industry. Likewise, industry has generally tended to accuse military policies and procurement regulations. Actually it is a 50-50 proposition, and no worthwhile progress in reliability improvement is likely to be obtained until we all realize our responsibilities and correct our mistakes."

You will naturally want to know what the Department of National Defence and industry are doing or should do in Canada to implement the needs for education in reliability and for applying reliability control effectively. The author is not in a position to present DND policies or its intended program, but can report, for the RCAF, that reliability requirements have become a major issue in deciding on new equipment to be adopted and Air Materiel Command has programs for the improvement of existing failure reporting, analysis and feedback of information, as well as for improvement of maintenance and logistics support factors influencing reliability, availability and serviceability.

Adequate guidance for management in industry in setting up reliability organizations can be found in many papers on the subject[10, 14, 15, 21] and in step-by-step guides on design and control. The need for the reliability group to be independent from design is not recognized by all advisers although, it may be pointed out, the relevant need for divorcing quality control from production responsibility is generally recognized. An extensive summary of reliability literature that has been screened critically by C. G. Moore[14] has recently been made available. Other bibliographies are being issued periodically by the U.S. Naval Electronics Laboratory and in the RETMA *Electronic Applications Reliability Review*. A chronological summary of major steps in establishing a military-industry reliability program in U.S.A. since 1950, listing important Defense Department directives

and establishment of new directives and study projects, has been prepared as an appendix to this address[a].

All those experienced in the reliability field agree that the understanding and support of a program by management is most vital; that reliability must be the concern not only of the specialists who are certainly essential in this new field but of every person concerned with or affecting its attainment; and that it must be a factor from the very beginning of any equipment program.

The attention of those who are especially interested in setting up reliability control activities is directed to the Institute of Radio Engineers Professional Groups on Reliability and Quality Control, on Electronic Components and on Military Electronics, and to their current publications and the annual symposia sponsored together with other engineering organizations. The latter are being well attended by representatives from both the military and industry in U.S.A., but are not yet supported in proportion to our need-to-know by Canadian engineers, especially from industry. The *Electronic Applications Reliability Review* published by the Engineering Department of the Radio-Electronics-Television Manufacturers Association in New York will be found of value to both industry and the Armed Services and is indicative of the zealous and competent cooperation being given to military agencies through industry's organized effort in the U.S.A.

Our victory in World War II owed a great deal to our technological superiority over the enemy in development of new weapons, including radar, sonar and proximity fuses in the electronics field. For our present defence needs we would be wise to heed Dr. Lusser's warning: "If we don't lick the reliability problem, it will lick us[10]."

ACKNOWLEDGMENTS

Grateful acknowledgment is made to Group Captain G. M. Fawcett, Senior Telecommunications Staff Officer, for his encouragement of the studies on which this address is based, and also to the late Air Vice Marshal R. C. Ripley, Air Officer Commanding, Air Materiel Command, for permission to present the views and data based on AMC experience.

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TECHNICAL FORUM

GAS TURBINE HISTORY

As I am a bit of a historical fiend, particularly with regard to aeronautics, I found the letter of Dr. Samaras in the June issue of the Journal very interesting. I am wondering if any of the members can throw any light on developments referred to in the article "Gas Turbine Engine" by W. Proudman in the June 1932 issue of the magazine "*Canadian Aviation*". A rather unique photograph of a small unit fitted with a variable pitch propeller accompanies the article.

Orangeville — C. J. Toms

VTOL: WE NEED IT

I was very intrigued to read the editorial of the June issue of the Canadian Aeronautical Journal, which I presume was inspired largely by S/L McCullough's paper entitled "A Canadian Look at VTOL Transport Aircraft", which paper I have not yet had time to study as it deserves. However, I was somewhat astonished to read the following sentence in the second paragraph of the editorial: "Furthermore, airfields can be relatively easily and cheaply built in developed areas, which attract most of the traffic". This sentence struck me first, but the sentence which follows it almost immediately astonished me almost as much, but from the strategic rather than the civil point of view.

Dealing with the first sentence, this is definitely not the situation as far as international civil aviation is concerned. One of the developments which has probably caused the most alarm in the last few years is the difficulty, expense and nuisance of planting enormous and ever-growing airports within a reasonable distance of the developed areas which originate traffic. In very few instances is it possible to put an aerodrome capable of serving the new generation of aircraft within a properly competitive distance from the points to which the passengers wish to go.

Unfortunately, the size of airports is dictated by the requirements of the most critical type of aircraft likely to use them. Statistics prove that only 2½% of all international passengers actually travel over a non-stop distance exceeding 2,000 miles, yet in most cases the remaining 97½% of passengers have to travel extra miles, to or from the airport, simply to cater to the requirements of the 2½% long distance travellers. (What this means in extra cab fare, man-hours and highway occupation should pay for a VTOL development programme easily, not to mention the fact that civil transport aviation is working itself out of the competition with railways, buses and private automobiles because it cannot offer sufficient advantages in the 100-150 mile range to attract mass transportation, and I think you will find that a surprisingly small percentage of the total population of even the most air-minded countries in the world actually enjoy the direct benefit of personal transportation by air.)

There is, therefore, the very strongest reason for developing VTOL or STOL to serve the densely populated areas of the country and, to my mind, a much stronger reason than the arguments in favour of the VTOL in the more sparsely populated regions of the Canadian North, which can traditionally get along reasonably well with the ski-plane and sea-plane for which nature has provided many landing places.

I am not quite sure what is meant by the sentence following the one quoted. I hope it does not mean that the military value of the large urban civil transport aerodrome is going to offer to our enemy, on a platter, a nice target on which he can annihilate the civil population with the same stone with which he is going to destroy our potential deterrent.

Montreal — A. Ferrier, A/V/M

(While we appreciate A/V/M Ferrier's arguments for the desirability of development of VTOL and STOL aircraft to improve air transportation, we feel that in fact the Canadian North and similar areas in other countries no longer can "get along reasonably well with the ski-plane and sea-plane for which nature has provided many landing places". On the contrary, it is rather in the densely populated areas that the pattern of air transportation is likely to develop along traditional lines, since development of VTOL aircraft which could match performance of civil machines now coming into use appears at present unlikely for purely technical reasons. As regards inconvenience to passengers, it might be effectively alleviated by other means, e.g. fast subway transportation to airfields.

The difficulties and expenses involved in airfield construction in the North should not require emphasizing in this country. The procedure of flame-cutting earth-working machinery, transporting the bits to a northern location in a "traditional" low-capacity, short-range plane, welding the parts together on the spot and using the re-assembled machines to build an air strip may serve as an extreme, and yet typical, example.

We have also attempted to point out that with the development of high performance aircraft and with the continuing shift from aircraft to missiles, the purely military need for VTOL has not been acute. It has been mostly felt in connection with construction of defence installations in the North, i.e. for reasons analogous to the civil ones.

A/V/M Ferrier's argument indicates that everyone needs VTOL; our point was that we need it, not only for everybody else's reasons, but, primarily, to develop the natural resources of Canada. — Sec.)

C.A.I. LOG

SECRETARY'S LETTER

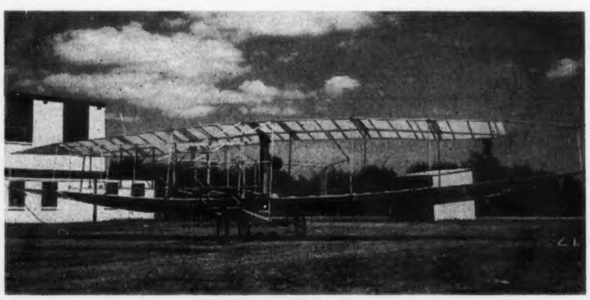
SILVER DART

SINCE the Annual Report was presented at the Annual General Meeting (it is now published on pages 244 to 252 of this issue) there have of course been several developments which have upset some of its predictions. The most notable concerns the proposal that the Institute should arrange for the building of a replica of the Silver Dart to mark the 50th Anniversary of flight in Canada.

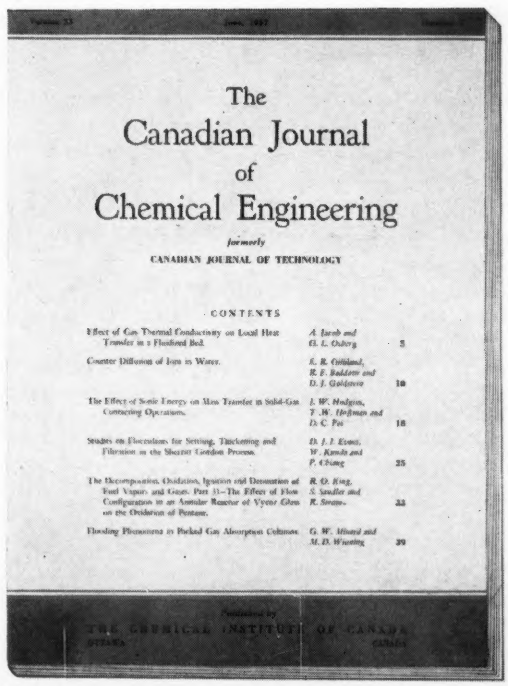
The Committee, appointed last January to study the feasibility of the suggestion, learned of a plan to build a replica at RCAF Station Trenton but received assurances that this plan would not go through. Accordingly it recommended to the Council that the C.A.I. project should be started and, as mentioned in the Annual Report, all our Sustaining Members were invited to participate. It was characteristic of our proposal that it should be a nationwide tribute to the occasion; we wanted as many people to participate as possible.

Then we discovered that the Trenton plan had gone ahead after all and, in fact, that a replica, less engine, was to be ready for Air Force Day this year. Mr. Kuhring, the Chairman of our Silver Dart Committee, Mr. Pelland, who had made the original suggestion, and I went and saw this aircraft and a very good replica it proved to be. On our report to the Council, it was decided that no purpose would be served by our building another replica and that the C.A.I. project should be abandoned.

So the Silver Dart Committee, comprising Mr. Kuhring, Mr. Pelland and Mr. Molson has been disbanded and we have had to tell our Sustaining Members



R.C.A.F. Silver Dart



The
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of
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the sad news. This was a great disappointment because the response had been most encouraging. However, we shall think of something else.

MORE FLATTERY

Last April I gave a half-scale reproduction of the lapel card used by the London Airport Branch, R.Ae.S., which had been developed from our standard card. I now reproduce the cover of a newly introduced journal (or rather an old journal in a new format) published by our friends the Chemical Institute of Canada; its origin, too, is not difficult to guess, though its colour is rather a green than a blue. It is particularly suitable that the C.I.C. should have taken this advantage of our design, because Dr. Garnet Page, their Secretary, gave us a great deal of help and encouragement in the early days of the Canadian Aeronautical Journal and, if anyone is entitled to a "rake off", he is. We are very

flattered to stand, in cover design at least, beside so eminent a publication.

INSTITUTE COMMITTEES

The duties of the various Institute Committees, which will guide our footsteps in the coming year, are referred to elsewhere in this issue, in the Reports of their predecessors; and their members are listed in the List of Members which has just been published. However, two new Committees have been appointed this year and it might be opportune to say a few words about them.

Long Range Planning Committee

This is a very important innovation. The Institute has now reached the stage where its finances will allow it to do more but where existing staff and office accommodation are loaded to the ultimate. Some pretty fundamental changes will have to be made and this Committee, comprising four senior members of the Institute under the Chairmanship of Mr. S. L. Britton, our Vice-President, is trying to evolve a Five Year Plan, setting up specific objectives and estimating the funds, manpower and facilities necessary to attain them.

Preliminary discussions were held at a joint meeting of this Committee and the Finance Committee in Toronto on the 25th July; the President and I were there too. It is too early to report any results, except to say that it was decided that we should move our Headquarters to slightly larger offices and appoint an Assistant Secretary to give me some relief. Of this more anon.

50th Anniversary

The Silver Dart replica, already referred to, was not the only idea which has been bandied about in connection with the Golden Jubilee celebrations and moreover, we know that every aeronautical organization in Canada is hatching schemes, which all together will result in chaos if not co-ordinated. So the President has appointed Commander E. B. Morris, a member of the Council from the Halifax-Dartmouth Branch, to be Chairman of a Committee, known as the 50th Anniversary Committee, to study this whole subject. Inasmuch as the first flight was made at Baddeck and the 50th Anniversary is something of a Nova Scotia occasion, Commander Morris' appointment seems rather appropriate.

ASSISTANT SECRETARY

As mentioned above, the appointment of an Assistant Secretary has been authorized by the Council and a notice, setting out the qualifications which this man should possess, appears on our advertisement pages. I refer to it here simply to draw attention to it, because it is most important that this position should be filled fairly soon; we can make precious little progress until it is.

SYMPOSIA

Two days after the I.A.S./C.A.I. Meeting, a symposium will be held in Ottawa to discuss the everlasting problem of nuts, bolts, swarf, tools, razor blades, pencils and other bits and pieces which get left in aeroplanes where they have no business to be. These things are always jamming controls, shorting junction boxes and causing similar mischief and no certain way has ever been found to eliminate the hazard.

The symposium will consist of a more or less open discussion in which everyone can participate and we hope that some useful ideas will emerge from it. We are inviting our Sustaining Members and other companies and Government Departments to send representatives, but the meeting will be open to all members of the C.A.I. who wish to attend.

If this symposium is a success, as I think it will be, the technique will be developed and perhaps we shall be able to arrange others on other subjects. If anyone has any ideas about subjects which might usefully be hashed over in a session of this sort, I should be glad if he would get in touch with me and I will refer his suggestion to the Programmes Committee.

I don't know whether "bomb scares" would fall within the scope of the proposed symposium. They might merit a meeting of their own!

ANNUAL GENERAL MEETING

THE fourth Annual General Meeting of the Institute was held in the Chateau Laurier, Ottawa, on the 27th and 28th May. The Annual Dinner took place in the evening of the first day. In general, the programme followed the pattern set in previous years, opening with a business session and continuing with technical sessions for the remainder of the two days. The registration for the technical sessions amounted to 434 and 628 attended the Dinner.

Part of the Head Table: (l to r) the Hon. J. A. D. McCurdy, Mrs. F. W. Baldwin, Mr. T. E. Stephenson (President), Mr. E. T. Jones and G/C H. R. Foottit

BUSINESS SESSION

Mr. M. S. Kuhring, Chairman of the Ottawa Branch, opened the proceedings with a few words of welcome. He then turned the meeting over to the President, who started the business of the day by presenting the Annual Report of the Council. He was followed by the Chairmen of the Finance, Admissions, Publications, Specialist Services and National Programmes Committees, each presenting his Report. (All these Reports are reproduced on pages 244 to 252 of this issue and will not be summarized here.) The Reports were accepted and there was no discussion or any other business.

THE DINNER

The retiring President, Mr. T. E. Stephenson, took the Chair at the Dinner and in the course of his address he reviewed briefly the continued growth and expansion of the Institute. He reported that the membership now exceeded 2,000 and that, with the establishment of the Halifax-Dartmouth Branch during the year, the Institute now spread its influence from coast to coast. He expressed his pleasure that Mr. Dexter, Secretary of the Institute of the Aeronautical Sciences, was present and had brought the good wishes of the I.A.S.* and he then read the following telegram from Dr. Ballantyne, Secretary of the Royal Aeronautical Society.

Mr. E. T. Jones, Principal Speaker

"President and Council of the Royal Aeronautical Society send greetings and good wishes for your fourth Annual General Meeting."

The President then said that, a few days before, he had sent a message to His Royal Highness The Prince Philip, Duke of Edinburgh, and he had just received a reply which, he felt sure, would give great pleasure to all those present. He read out his message and the reply:

"The Canadian Aeronautical Institute, which Your Royal Highness had honoured with your Patronage, will hold its Annual General Meeting in Ottawa on the 27th and 28th May. On this occasion, on behalf of the members of the Institute, the Council wishes me to convey to Your Royal Highness our greetings and good wishes. This message will be brought to the attention of those attending the Annual Dinner on the 27th May and we know that it will receive their sincere commendation.

T. E. Stephenson, President"

"I send my thanks to you and all members of the Canadian Aeronautical Institute for their kind message of greetings on the occasion of the Annual General Meeting and the Annual Dinner on the 27th and 28th May. I hope both the Meeting and the Dinner will prove a great success and I send my very best wishes to all members of the Institute for the future.

Philip Patron"

This exchange of messages was warmly applauded.

Turning to the matter of honours and awards, the President repeated the names of the seven members elected to the grade of Fellow (as announced at the Business Session in the morning, see page 247) and he also announced that

*The following telegram from Mr. Paul Johnston, Director of the I.A.S., was unfortunately received too late to be read out:

"Am extremely sorry that I cannot be with you tonight . . . Best wishes for a most successful affair."

F. W. (Casey) Baldwin Award Winners Dr. P. Mandl and Mr. H. T. Stevinson

Honorary Fellowships had been bestowed upon

Mr. M. E. Ashton, and
Mr. W. F. English

He expressed deep regret that sickness prevented both of them from being present.

The President then referred to the major annual awards of the Institute and said that, in addition to the McCurdy Award and the W. Rupert Turnbull Lecture, a silver medal had been introduced to commemorate the great contribution made by the late F. W. (Casey) Baldwin. The F. W. (Casey) Baldwin Award, as it would be known, would be presented to the author of the best paper published in the Canadian Aeronautical Journal each year. Mrs. Baldwin had honoured the Institute by coming to Ottawa from her home in New York to make the first presentation of this Award and, the President added, she had not been in Ottawa since 1909.

The winning paper, entitled "A Repeating Parachute", had been published in the Journal in February 1956, after having been presented in a rather fuller form at the Annual General Meeting in 1955. Its authors were Mr. H. T. Stevinson and Dr. P. Mandl of the National Research Council, who duly accepted the Award from Mrs. Baldwin's hands.

The President then asked the Hon. J. A. D. McCurdy to present the McCurdy Award for 1956 to Mr. E. K. Brownridge of Orenda Engines Ltd., and he read the citation prepared by the Selection Committee. In a brief reply, Mr. Brownridge paid tribute to all those who had contributed to the success of the Orenda engine, mentioning those who were no longer directly associated with it, A/M W. A. Curtis, Mr. C. D. Howe, Sir Roy Dobson, Mr. F. T. Smye, Mr. P. B. Dilworth, Mr. Winnett Boyd and Mr. J. F. Taylor and, collectively, all those still employed at the Company.

The final item on the programme was the delivery of the Principal Address by Mr. E. T. Jones, Director General of Technical Development (Air), Ministry of Supply, and immediate Past President of the Royal Aeronautical Society. Mr. Jones' notable lecture is reproduced in full in this issue. At its conclusion he was thanked on behalf of the Institute by Mr. J. L. Orr, Ottawa representative on the Council.

As his last act, the President introduced his successor, G/C H. R. Foottit. After receiving the President's Badge from Mr. Stephenson, the new President expressed the hope that he would tread worthily in the steps of Dr. Green, Mr. Richmond and Mr. Stephenson. The Dinner was then adjourned.

New President, G/C H. R. Foottit, taking over from the Past-President, Mr. T. E. Stephenson

TECHNICAL SESSIONS

The programme of technical sessions is reviewed as follows:

Morning Session, May 27th
Design and Structures

Reported by F. R. Thurston

The Chairman for this Session was Mr. R. E. Klein, Chief Stress Engineer of De Havilland Aircraft of Canada Ltd., and the first paper was entitled "Structural Testing the RCAF Argus" by Mr. C. A. Bloom, Section Chief of Structural Test, Canadair Ltd.

Mr. Bloom introduced his subject by first describing the structural and production differences between the Argus and its progenitor, the Bristol Britannia. Briefly, it was explained that fundamental changes had been made in the fuselage and vertical stabilizer structures, that engine nacelle structure had been altered to accommodate reciprocating engines and that redesign of landing gear components had also involved a reduction in hydraulic system pressure from 4000 psi to 3000 psi.

In addition to structural changes made for functional purposes, the design of the Argus was conditioned to American materials, processes and standards.

Although the scope of structural tests on the Britannia was most comprehensive, the changes outlined necessitated a very large programme of tests for the Argus, some of which were made on a comparative basis only, to demonstrate the ability of new designs or methods to achieve prototype strengths.

A considerable variety of tests were described, many of them conventional, some of them involving complex test rigs and procedures, and all of them subscribing to the conviction that the extent and value of structure testing increases year by year. The original paper should be consulted for details (in the form of photographs) of the test rigs employed.

Design and Structures Session: (l to r) Mr. C. A. Bloom, Mr. R. E. Klein (Chairman) and Mr. G. F. W. McCaffrey

Test Pilots Section: (l to r) S/L O. B. Philp, Mr. W. S. Longhurst (Chairman) and F/L K. D. J. Owen

Test Pilots Section Annual Business Meeting: Mr. J. Zurakowski, Chairman of the Specification Standardization Committee, delivering his report.

There was considerable discussion subsequent to the presentation of this paper, much of it related to technical details of testing procedure, but some in the form of criticism of what is now commonplace fatigue testing philosophy. The statistical nature of fatigue endurance will not disappear by being ignored and Mr. Bloom's reference to "Fail Safe" design struck a more responsive chord than the policy of checking the endurance of a very few samples.

The second and last paper of the session was presented by Mr. G. F. W. McCaffrey, Chief Engineer of Dowty Equipment of Canada Ltd. The paper was entitled "The Application of Ultra High Tensile Steel to the Design of a Modern Undercarriage".

This paper was primarily an account of the metallurgical and manufacturing problems associated with the design of an undercarriage using SAE 4340 steel with an ultimate tensile strength of 260,000 to 280,000 psi. No structural analysis was given to justify the use of this material.

The design of the undercarriage was conditioned by the necessity for stowing a very long undercarriage, mounted on a skew axis, in a very limited space in a thin wing, and by the requirement that the undercarriage had to be shortened, twisted and trimmed during retraction.

After a thorough appraisal of existing ultra-high tensile steels, the decision was taken to choose SAE 4340 and to achieve an acceptable quality by a close control of melting practice and a rigid schedule of testing. Components in the form of forgings of up to 1000 lb weight were machined and then heat-treated in a neutral salt bath, quenched in oil and double tempered.

Mr. McCaffrey presented a number of curves illustrating the properties of this material from which it appeared that the low stress level fatigue resistance was relatively high while the high stress level fatigue resistance was relatively low. He inferred that in normal operations the failure rate would be acceptable and that early failures would properly fall within the exclusive interest of the accident investigation authorities. It is felt by the writer that the continuous nature of relevant statistical load frequency distributions dictates further attention to the short endurance ($< 10^3$ cycles) fatigue resistance.

Curves were also presented to illustrate the phenomenon of room temperature creep (so-called static fatigue) which is a rather surprising and little understood characteristic of these materials.

The paper as a whole did much to evoke interest in the use of ultra high strength steels and the author's appeal for more fundamental research on this subject was timely.

Following presentation of the paper and in answer to questions, Mr. McCaffrey explained that dynamic interaction of the undercarriage with the aircraft wing was responsible for the fact that the anti-drag loads designed the gear structure in bending; he did not envisage extensive fatigue tests on the completed undercarriage but expected to substitute fatigue tests on large specimens; he did not use the drop tests to check the stressing and thus justify the use of the material, but rather to evaluate the response of the undercarriage.

Afternoon Session, May 27th
Test Pilots Section

Reported by W. Gadzos

Mr. W. S. Longhurst presided over the meeting. After dispensing with the affairs of a brief business agenda, at which Mr. Cooper-Slipper and Mr. Zurakowski presented the reports of the Committees on Instrument Flying and Specification Standardization, Mr. Longhurst called on S/L O. B. Philp to give the first part of the paper, "The Test Pilot and The Flight Test Engineer", prepared by S/L Philp and F/L K. D. J. Owen.

S/L Philp introduced the subject by pointing out that a unique relationship existed between the test pilot and the flight test engineer and that these specialists combined their activities to form a flight test team. The lack of teamwork can result in unnecessary cost and can even be disastrous to national security.

S/L Philp, who until recently supervised the flying activities of CEPE as Chief Test Pilot, defined test flying as the ultimate test of aeronautical theory or engineering practice. He described the test pilot as the one who directs and controls the operation of an aircraft in the search for facts; one who depends on the flight test engineer to determine the requirements of a test and to analyze the results. He described the test pilot's job in four distinct forms, as follows.

In Research Test Flying, the pilot must have a clear understanding of the theoretical aspects of the test, in the language of the engineer, and must relate the test to a practical flight case for the conduct of a successful flight with a minimum amount of hazard.

In Development Test Flying, the test pilot should have a sound understanding of design engineering problems and of operational needs and his knowledge should be put to use during the design and development phases, where his initiative and ambition may be stimulated by a recognition of his personal ability and responsibility.

In Production Test Flying, the test pilot familiar with an aircraft's characteristics can make important contributions as a recognized member of the production development team.

In Maintenance Test Flying, a pilot's knowledge and experience can be used, as in Production Testing, to further improve the aircraft and installations.

S/L Philp emphasized the qualifications and training needed by test pilots, especially the importance of sufficient technical knowledge to enable a test pilot to talk with scientists and engineers using their terms and definitions. He stressed the value of the training obtained at test pilot schools, which reduced the time required in on-the-job experience to produce a qualified test pilot.

S/L Philp then introduced F/L Owen, who presented the flight test engineer's point of view.

F/L Owen described the prime function of the flight test engineer to be to analyze results and present the facts to higher authority. He claimed that the flight test engineer, who is concerned with a flight test program in all its aspects – directives, logistics, techniques and methods, data acquistion, reduction and analysis, reports – cannot come by the experience required of him overnight. He defined a flight test engineer as an aeronautical engineer with specialized training and on-the-job experience.

For the success of a test program, dependent on an acceptable engineer-pilot relationship, F/L Owen presented four basic factors – a common objective, appreciation of each other's job, faith in each other's ability and common references.

For the first, it was claimed that a clear directive must be given; then the engineer and pilot could work as a team towards a common goal. An important aspect of a common objective, said the speaker, is the personal one, where recognition of risks taken and freedom to discuss their findings would create in the pilot and engineer greater personal motivation; the degree of recognition and freedom is indicated by the position held by these specialists in the organizational framework. It was stressed that flight test personnel should report directly to senior management levels.

A common training facility for the pilot and engineer, it was said, would be the solution to the difficulties that engineers and pilots encounter in learning to appreciate each other's job. Such a facility would also be the builder of confidence between the pilot and engineer. A common training facility would provide for common references. This would be only a starting point; it was emphasized that there was a continual requirement for the pilot and engineer to review and progress with the changing methods and techniques.

F/L Owen saw the present situation in the RCAF as one where too few people were trained in the art of flight testing; the training of such people was still in its infancy. The industry, he felt, was possibly worse off than the RCAF in the ability to test and establish the quality and utilization of aircraft. It was stated that in the RCAF there was greater freedom for visiting foreign establishments and greater latitude for discussion; the RCAF's position regarding security regulations was far more flexible than the industry's.

S/L Philp followed F/L Owen to the podium to present the conclusions. It would seem that with the test pilot getting the first and last words, the flight test engineer had not yet found the common ground for compromise with the test pilot. However, in his concluding remarks, S/L Philp re-emphasized the important link that the pilot-engineer team made between the designer and the operator. He called for a common basic training for pilots and engineers that they may produce the required results. He stressed that the high costs of flight testing demand that this work be done by qualified and experienced personnel, by specialists trained to work as an efficient team. In his final statement, S/L Philp pointed out that within the framework of the C.A.I. were the opportunities for pilots and engineers to pursue the common ground of understanding.

Time did not permit having a discussion period and after Mr. Longhurst thanked the speakers he called on Mr. D. H. Rogers to introduce the film "Air Power". This film, which showed the flight testing of the F-104, was very interesting and well received.

Afternoon Session, May 27th
Materials

Reported by F/L J. L. Adamson

Three papers were presented at the Materials Session, held in the afternoon of the 27th May, under the very capable chairmanship of S/L W. G. Chandler of the RCAF Quality Control Laboratory. The first by Mr. J. A. Fortune, Metallurgist, Orenda Engines Ltd., was entitled "The Application of Non-metallic Materials to Gas Turbine Engines".

The paper was both informative and controversial. The facts which revealed the present uses and the potential capacity of elastomers and ceramic materials to an industry which has been monopolized by metallic materials in the past, was received by those in the aircraft industry with amazement and by those of the metals industry with doubt and chagrin. Mr. Fortune was confronted by some provocative and controversial questions which he convincingly answered to the satisfaction of his audience.

The second paper, presented by Mr. K. B. Young, Metallurgical Engineer, Development and Research Division, The International Nickel Co. of Canada Ltd., was entitled "High Strength Nickel Chrome Alloys for Elevated Temperature Service". Its theme was the development of new alloys which are capable of meeting the high temperature demands of alloys used in the development of gas turbine engines and high velocity military products. Mr. Young pointed out that the high temperature characteristics of alloys demanded was not the only significant complication in their development. He said that high strength and light weight factors are of

Materials Session: (l to r) Mr. S. C. M. Ambler, Mr. R. O. Campbell, S/L W. G. Chandler (Chairman), Mr. K. B. Young and Mr. J. A. Fortune

utmost importance in gas turbine development.

Mr. Young reviewed the history of the high strength, high temperature applications of nickel-chromium alloys. He said that their oxidation-resistant qualities had been recognized for over fifty years but only within the last fifteen years had this group of materials gained prominence, a corresponding period to the development of gas turbine engines.

Following the revelation of some interesting details and facts regarding the properties and influence of heat treatment and composition on some of the nickel-chromium alloys, a brisk question and answer period was held.

"Trends in Lubrication" was the title of the third paper in the Session. This paper was delivered by Mr. S. C. M. Ambler and Mr. R. O. Campbell of the British American Oil Company.

The B.A. Oil paper was the first, I hope, of many more papers on a material which is not given the recognition it is entitled to. The development of high powered, complex mechanisms which are intended to perform a certain function under wide ranges of atmospheric conditions has created a host of lubricant development complications, most of which have been successfully solved by the use of synthetic lubricants.

Mr. Ambler said that it was logical to assume that future lubricants will be basically petroleum, containing better supplementary chemical additives but, to hasten this development, close cooperation between manufacturer and the petroleum refiners is necessary.

Following delivery of this most informative paper, questions were expertly answered by the authorities.

Morning Session, May 28th
Noise

Reported by R. Westley

The Session on Noise, held in the Convention Hall in the morning of the second day of the meeting, was confined to two papers, both of which aroused considerable interest and discussion. Mr. Winnett Boyd, President of the consulting firm of Winnett Boyd Ltd., was in the Chair.

The first paper was delivered by Professor E. J. Richards, Head of the Aeronautical Engineering Department at the University of Southampton, and was entitled "Noise Research in the United Kingdom".

The paper outlined the problems of aircraft noise, the progress of U.K. noise research during the last few years and gave a comprehensive survey of the latest developments.

Professor Richards pointed out the difficulty of assessing the annoyance from aircraft noise but, nevertheless, said that their aim was to reduce the noise of jet airliners by 10-15 db when in the air and by about 30 db during ground running. He added that much of the noise suppression work was sponsored by outside contracts from the Ministry of Supply with the Universities supplying the fundamental background for the engine and airframe firms.

Noise Session: (l to r) Professor E. J. Richards, Mr. Winnett Boyd (Chairman) and Dr. K. K. Neely

The importance of Lighthill's classical aerodynamic theory to the understanding of the source of subsonic jet was discussed together with experimental verifications. It was pointed out that detailed application of the theory and the prediction of near noise fields depended on the development of more advanced methods for measuring turbulence.

A description was given of studies on jets which contained shock waves. This included the resonance mechanism and the noise radiated when eddies and 'hot spots' were convected through shock waves. It was shown that a convergent divergent nozzle could reduce this type of noise if it were operating at its design pressure ratio.

Once more Professor Richards appealed to aircraft planners for a fundamental approach to reduce noise. He reminded them that this was possible by a reduction of engine power or by the use of larger engines with lower jet velocities. He discussed the development of the corrugated nozzle for jet engine silencing and suggested that the trailing edge slot nozzle could give useful silencing for helicopters or aircraft with jet flaps.

The wide angle diffuser and the peripheral spreader were described as novel developments which might solve the problem of the portable ground muffler.

It was stated that experimental and theoretical work has been started on structural fatigue due to noise and this will be advanced by a device which will measure the space and time correlations of the noise fields.

In concluding his lecture, Professor Richards mentioned studies on boundary layer noise from both rigid and flexible walls, the increased interest in propeller noise due to the success and quietness of turboprop aircraft and the work done to silence helicopters.

The second paper was given by Dr. K. K. Neely, Chief of Sonics Section, Defence Research Medical Laboratories, and was entitled "Noise – Some Implications for Aviation".

Dr. Neely discussed the noise problems associated with airport operations and pointed out that it had now become one of the important problems of modern aviation. He stated that loss of hearing, interference with voice communication, loss of efficiency, body damage and annoyance could result from exposure to high intensity noise.

Diagrams illustrated that, although the cabin noise of jet aircraft was much quieter than in piston engine aircraft, the outside noise was considerably greater and in fact noise levels which rarely exceeded 120 db a few years ago were now often 140-150 db.

It was indicated that, although the threshold of pain was about 130 db, both temporary and permanent hearing

Antiicing and Deicing Session: (l to r) Mr. J. R. Stallabrass, Mr. B. Quan, Mr. O. R. Ballard, Mr. J. H. Parkin (Chairman), Mr. C. K. Rush and Mr. D. Quan.

losses could result from continuous exposures as low as 85 db. As a result, he said that RCAF criteria now require ear plugs or muffs if exposure is longer than four hours between 85-100 db and no exposure is permitted above 150 db. It was pointed out that listening intelligibility was increased by the use of ear plugs and that a combination of plugs and muffs increased the hearer's protection. Exposure to noise levels above 140-145 db was said to be capable of causing vertigo or nausea and eardrum rupture was likely at 160 db. The Sonics Section had been investigating body protection in these higher noise level ranges.

The problem of voice interruption was discussed together with its importance to military and civilian communications. This problem affected the location of RCAF control towers and it was stated that there was a need to develop equipment which would give adequate voice communication in noise levels above 120-125 db.

The speaker concluded by discussing a number of methods which might help to solve the acute airport noise problem which was imminent. He said that ground silencing installations were effective but expensive and that, although not adequate, airborne silencers gave some reduction of jet noise. The planning of airports with buffer zones to isolate them from neighbouring communities and long runways to allow reduced takeoff power were suggested together with separations of at least 2½ miles between runways and administration offices. Regulations were advocated which would prohibit the landing of noisy aircraft and it was stressed that these regulations should be considered by manufacturers at an early design stage. Finally a warning was given that helicopters and vertical takeoff aircraft would be noisy and might not be acceptable near city centres.

Morning Session, May 28th
Antiicing and Deicing

Reported by H. Aass

The Session was opened by the Chairman, Mr. J. H. Parkin, Mechanical Engineering Division, National Research Council, who introduced Mr. J. R. Stallabrass, Assistant Research Officer, Low Temperature Laboratory, National Research Council, whose paper was titled "Some Aspects of Helicopter Icing".

Mr. Stallabrass started by discussing the requirements for an icing protection system for helicopters and described how the National Research Council approached this problem. The special spray rig, constructed for the in-flight study of the phenomenon and for the testing of protective systems, was described. Some of the results obtained by using the spray rig were mentioned. The effects of rotor blade icing on performance and handling of the helicopter were discussed together with special design considerations due to icing on items other than primary lifting surfaces.

The speaker's remarks offered evidence that some type of icing protection is necessary and offered suggestions as to the best means of protection for the various parts of the helicopter. Mr. Stallabrass concluded his paper by stating his views on icing detection for helicopters.

The second paper in this Session was delivered by Mr. C. K. Rush, National Research Council, and Mr. D. Quan, Orenda Engines Ltd., and was titled "Aircraft Gas Turbine Ice Prevention: The Design and Development of Hot Air Surface Heating Systems". Mr. Rush presented, from a designer's point of view, the problem of protecting an aircraft gas turbine engine from the hazards of icing. The basic objective is a system having minimum weight and performance penalties together with maximum duration of protection and reliability. Consideration of various available protective methods points to the hot air surface heated system as a satisfactory compromise, provided a control system is used to prevent waste of hot air. The speaker pointed out that the choice of an icing protection system may be influenced by the type of aircraft in which the engine is to be installed. But the engine manufacturer cannot foresee all applications for an engine at the design stage and some flexibility is required in order to meet different operational needs with a minimum of modifications. The design of such a system was then considered and it was pointed out that the many assumptions which are made lead to the necessity of development tests so that the design may be proved and refined.

In conclusion, Mr. Quan stated that the suggested method of developing gas turbine icing protection systems should greatly reduce the overall time for the design-development cycle. In particular, by utilizing icing wind tunnels to the maximum extent, the misfortune of discovering a major deficiency during the latter stages of testing can be avoided.

A spirited discussion followed the delivery of the paper, touching on the ice detection systems incorporated during design stages.

The last paper in this Session was titled "Ice Crystals: A New Icing Hazard" and was delivered by Mr. O. R. Ballard, D. Napier & Sons Ltd., and Mr. B. Quan, National Research Council.

The speaker introduced the audience to this new problem in icing that has been brought about due to recent experiences when flying through ice crystal clouds. The nature of these clouds and the effect of crystal ice formation on anti-icing systems designed for supercooled droplet icing were considered.

Various methods for simulating icing conditions were reviewed and the methods used at National Research Council for full scale gas turbine tests

were described. Mr. Ballard listed the meteorological icing conditions necessary and described the mechanism of ice formation. Precise information on ice crystal clouds, however, is limited since in the past they have not generally been regarded as hazardous and very little data has, therefore, been collected.

The speaker pointed out the importance of ice detection systems which distinguish between supercooled droplets and ice crystal clouds, so that the ice crystal hazards can be minimized in the design stage of an aircraft or engine.

He concluded with an urgent appeal to the meteorological departments to establish limiting geographical extents and altitudes of ice crystals and mixed clouds in order that standard conditions for testing and approval of aircraft can be formulated.

Afternoon Session, May 28th
Aviation Medicine and Human Engineering

Reported by S/L W. M. McLeish

The Session was under the Chairmanship of A/C A. A. G. Corbet, Director General Medical Services Air, RCAF.

The first speaker, Mr. R. E. F. Lewis, Human Factors Engineer, Avro Aircraft Ltd., dealt with the origin, nature and application of human engineering in a paper entitled "Introduction of Human Engineering".

Mr. Lewis traced the need for man/machine relationships which arose during the Second World War and indicated that the psychological studies which followed gave an opportunity for psychologists to study engineering design problems. This work led ultimately to the present field of human engineering, which is also referred to as "human factors engineering" or "human factors and engineering psychology". Several specialists were referred to by Mr. Lewis as being the pioneers in the field and these included Sir Frederic Bartlett and Dr. N. H. Mackworth of Great Britain, Dr. Ross McFarland and Dr. Paul Fitts of the U.S.A., and Dr. Morley Whillans and Dr. Reg Bromiley of Canada.

In introducing the audience to his subject, Mr. Lewis discussed the term "man/machine efficiency" and provided some simple examples to illustrate its importance. In essence, the object of this parameter is not merely to increase machine accuracies but to design the machine so that, when coupled with human inconsistencies, the product is the most efficient compromise between man hour expenditures, machine economies and functional reliability.

The audience was then informed of the role of human engineering in the aircraft industry. It is important to consider the point of view of the human engineer at the design stage if he is to make a satisfactory contribution. This results from the fact that the design engineer cannot obtain guidance from handbooks. Basic factors are as follows:

(a) The mission dictates cockpit requirements
(b) Instrument presentation
(c) Vision from cockpit
(d) Cockpit lighting
(e) Cockpit environment
(f) Cockpit intercommunication
(g) Escape in an emergency
(h) Ground handling equipment

The need for research work in engineering psychology was stressed by Mr. Lewis, such as the relative merits of audio vs visual data presentation and the compromise between identity of information and simple presentation.

The human engineer should possess four major characteristics to be successful; these are applied psychology training, a strong analytical persuasive personality, a practical nature and, if he is not a pilot, he should be prepared to fly often. As to the future, more individuals must be enticed into the field and universities should consider including courses in human engineering in all engineering curricula. There was no discussion period of any note and most questions were of a review nature.

The second paper, a presentation by Canadian Pacific Air Lines, dealt with the subject of airline safety and economy. It was entitled "Safety First and Always" and was delivered by Mr. R. J. Burden. In the opinion of this reporter, its subject matter did not relate to aviation medicine and it would be difficult to classify it as human engineering, except in the broadest sense.

However, the paper was extremely interesting because it illustrated the extent to which an airline must plan the purchase of new aircraft. Not only must the aircraft performance be satisfactory, but considerable time is spent on the interior layout of the passenger cabin to ensure that adequate exits exist, that fire extinguishers are adequately placed, life rafts and portable emergency oxygen must be considered as well as g tolerance seats, and all this given a pleasing appearance with maximum comfort and functional efficiency.

Mr. Burden devoted some time to the problem of cockpit layouts and their relation to navigational equipment, all with an eye to crew comfort and aircraft safety.

A brief review of the CPA maintenance check system was made and some generalizations were stated on the subject of component histories and overhaul hours.

The third paper was presented by S/L R. A. Stubbs of the RCAF Institute of Aviation Medicine; it was entitled "Specific Aeromedical Problems in High Performance Aircraft".

S/L Stubbs discussed the effects of altitude and airspeed with the aid of a hypothetical flight envelope of a high performance aircraft. Commencing with a review of the pressure lapse with altitude, the problem of the use of oxygen above 38,000 ft was introduced. S/L Stubbs emphasized the need for pressure breathing to establish a satisfactory pressure differential in the lungs above the ambient pressure. Without this pressure differential, the oxygen in the lungs is not effective and cannot saturate the blood and body tissues. Thus, above 38,000 ft, oxygen must be supplied under

Aviation Medicine and Human Engineering Session: (l to r) S/L R. A. Stubbs, Mr. R. J. Burden, A/C A. A. G. Corbet (Chairman) and Mr. R. E. F. Lewis

Aerodynamics Session: audience discussion

Aerodynamics Session: (l to r) Mr. H. C. Eatock, Dr. G. W. Johnston, Mr. S. J. Pope and Mr. R. J. Templin (Chairman)

pressure and the breathing cycle must be adjusted to a lower rate; the consequences without it are unconsciousness and total collapse within seconds.

Physical distress due to trapped gases in the stomach and nitrogen in the body tissues is another effect of the altitude pressure lapse. The magnitude of distress is a function of age, obesity, emotional state, rate of ascent, temperature, duration of exposure and decompression experience. The current research in this field is hampered by the fact that earlier work cannot be extrapolated to the high ascent rates and high level exposure times of the modern aircraft.

The use of pressure cabins was reviewed in some detail and led to a discussion of decompression problems which are presently being studied at the RCAF Institute of Aviation Medicine. The Institute is developing pressure clothing to enable aircrews to survive at altitudes above 48,000 ft should the cabin be decompressed. At best, such garments can only protect the head and trunk of the body and consequently their use is restricted to 65,000 ft for a maximum of five minutes, after which a rapid descent to 38,000 ft is required.

An additional cabin pressurization problem arises at approximately 65,000 ft, where it is no longer possible to use engine compressed air as a source due to the rare ambient atmosphere. Thus, more power must be taken from the engine to achieve pressurization and extreme air temperature results. There is also the problem of the ozone concentration above 90,000 ft, which when compressed leads to toxicity problems. Thus, above 70,000 ft it is probable that sealed cabins, complete with pressurizing and ventilating gas, will be carried and some form of purification and recirculation will be required.

Airspeed poses its own problems, such as high g during manoeuvre flight resulting in fatigue and aerodynamic heating which will be impossible to cope with if the aircraft cabin cooling fails.

In summary, with the advent of high performance aircraft, physical stresses due to low ambient pressure, pressure breathing, prolonged low accelerations and abnormal heat, must be considered jointly with those mental and biochemical stresses which may have been present prior to flight, such as anxiety and low blood sugar. The combined problem is complex and will require the efforts of a great number of people for its solution.

S/L Stubbs finished with a summary of the ejection problem which, though briefly covered, was all inclusive nevertheless. Essentially the problem areas are high speed and low altitude. High speed difficulties arise from aerodynamic forces encountered on entering the airstream, which give rise to decelerations in excess of human tolerance. The solution appears to lie in the use of the capsule with rocket assisted ejection.

Many questions arose as to the progress of research into the many problems and S/L Stubbs was obliged to deal briefly with the queries, due to the complexities of the answers. The high interest shown by the audience suggested that some of the individual problems could well be the subject of future papers at future meetings.

Afternoon Session, May 28th
Aerodynamics

Reported by J. Lukasiewicz

This Session, which took the form of a panel discussion on Supercirculation, was chaired by Mr. R. J. Templin, Head of the Aerodynamics Section, National Research Council. Mr. Templin pointed out in the introduction that this Session was of interest both from the technical point of view and as the first CAI experiment in panel discussions. The term supercirculation, first introduced by Attinello in 1953, had quite a definite and rather narrow meaning; actually, the discussion might well include the problem of boundary layer control as well as supercirculation and would, in general, be concerned with applications to takeoff and landing phases of flight.

The first speaker, Mr. S. J. Pope, Chief Aerodynamicist, Canadair Ltd., stressed the fact that in practical considerations of applications of boundary layer control the safety and weight aspects were as important as the aerodynamic ones. Performance estimates indicated that for a Proteus-Britannia aircraft the takeoff distance (to clear a 50 ft obstacle) could be reduced by 40% with boundary layer control, but that with one engine cut only an 18% gain could be realized. On the other hand, by utilizing the slipstream rather than compressed air bleed for boundary layer control and high lift, the takeoff distance was reduced by 23% with all four engines on and by 22% with one engine cut. This comparison indicated the desirability of the slipstream application from the safety point of view.

Mr. Pope pointed out that it was found uneconomical usually to go beyond boundary layer control, i.e. to pure supercirculation, in obtaining high lift coefficients. In practice, the use of boundary layer control would require, from the point of view of safety, interconnection of compressed air supplies and of sources of compressor power and would result, at least with conventional aircraft designs, in large weight penalties. It is for this reason that the question of applicability of conventional reliability requirements to boundary layer control aircraft might have to be carefully looked into.

The next speaker, Dr. G. W. Johnston, Special Projects Engineer, De Havilland Aircraft of Canada Ltd., described the work under way at De Havilland on applications of slipstream to obtain high lift coefficients. Full scale tests were performed on an Otter aircraft instrumented for measurements of five components. The interaction between slipstream, high aspect ratio wing and flaps was studied both experimentally and theoretically. The slipstream effect was found to spread over 70% of the wing span. These investigations were supported by a DRB contract.

Mr. H. C. Eatock, Supervisor of Aerodynamics, Orenda Engines Ltd., was the third speaker and he discussed in some detail the theoretical and experimental work published in France and England on the so-called jet flap. He questioned the possibility of obtaining full thrust recovery, irrespective of the inclination of the jet flap, and felt that the test results available so far are inconclusive in this respect.

Mr. Eatock's talk was followed by a lively, albeit inconclusive, discussion. In general, the impression was that it was difficult to foresee how jet flap could be utilized in practice and that slipstream deflection schemes might be more worthwhile.

Copies of Papers

Preprints of the papers presented at the Annual General Meeting on the 27th and 28th May are obtainable from the Secretary.

THE McCURDY AWARD — 1956

THE presentation of the McCurdy Award for 1956 was made by the Hon. J. A. D. McCurdy at the Annual Dinner which was held in Ottawa on the 27th May, 1957. Mr. E. K. Brownridge, Vice-President, Manufacturing, Orenda Engines Ltd., was the recipient.

The Citation reads as follows:

Mr. Earle K. Brownridge has been selected as the winner of the McCurdy Award for 1956 for his outstanding contributions over the past few years in the manufacture and production of gas turbine engines. In his successive posts of Assistant Production Manager, Production Manager and Vice-President, Manufacturing, of the Gas Turbine Division of A. V. Roe Canada Ltd. and Orenda Engines Ltd., he has been responsible for the conception, organization and growth of the Orenda production plant, from its embryonic origin in the fall of 1949 to its present eminent position among the foremost aero engine production organizations in the world.

Mr. E. K. Brownridge (l) receiving the McCurdy Award for 1956 from the Hon. J. A. D. McCurdy. Mrs. F. W. Baldwin is in the foreground.

Working against time and concurrent with an ever expanding objective, which increased fivefold before the first production unit had been manufactured, Mr. Brownridge started from scratch to set up an organization and facilities to carry out the process planning, tool design, tool manufacture and production for the Orenda jet engine program.

This program had to proceed in parallel with continuing development and related design changes in the Orenda engine and under conditions where there was an acute shortage of both manufacturing equipment and skilled personnel. It also necessitated the design, fabrication and equipping of a very large new plant and the transfer of initial manufacturing facilities from their original location in an Avro Aircraft Plant assembly bay to the new Orenda production factory.

Notwithstanding these obstacles, the Orenda production program achieved a truly remarkable schedule, highlighted by the delivery of the first two production engines (for type test) by December 31, 1951, opening of the new plant in September 1952, achievement of peak production by May 1953, production of the first 1,000 engines by February 1954 and the second 1,000 engines by February 1955. Concurrently the cost of engine production in terms of dollars per pound of thrust was steadily and substantially reduced.

The manufacturing and production techniques evolved at Orenda Engines Ltd. under Mr. Brownridge's direction have aroused widespread interest and particular mention might be made of the fabrication in titanium in the manufacture of the new Iroquois engine. An imaginative approach to many new production problems has reflected Mr. Brownridge's vivid personality and sound judgment. His ability to work effectively with an engineering team on advanced design and development programs has been an outstanding characteristic.

With no previous manufacturing experience, Mr. Brownridge joined Victory Aircraft Ltd. as a Time Study Clerk in 1944 and he has remained at Malton ever since. His career is, in itself, an inspiration to all engaged in Canadian aviation and the development of the manufacturing and production potential of Orenda Engines Ltd. is an eloquent expression of his personal energy and initiative and his outstanding ability in organization and leadership.

ANNUAL REPORT

Of the Council

1956-57

THE C.A.I. can look back on its third year as one of vigorous development and service. The activities established in former years have been expanded, membership has continued to increase, new Branches have been formed and new features have been introduced into the programme. Details will be given later but first the Council must give an account of its own stewardship.

COUNCIL

The full Council has met three times since it took office — and this is not counting the joint meeting of the retiring and the new Councils which took place yesterday. The first meeting was held in Montreal at the end of the Annual General Meeting last year; on this occasion, since this Council had only just taken over from its predecessor, little more could be done than appoint Committees and lay broad plans for the year ahead. The second meeting took place in Toronto, at the time of the I.A.S./C.A.I. Meeting last November; no less than fifteen of the seventeen members managed to be present and a great deal was accomplished. The third meeting was held in Winnipeg in February; again, it was well attended and covered a wide field of Institute business. This meeting in the West arose from a suggestion put forward by the Past President, when he retired from office last May. It was a good idea.

It will be remembered that the members of the Council are elected by the individual Branches and that the By-laws specify a quorum as comprising at least one member from each Branch. With Branches scattered right across the country, it is no mean achievement to gather a quorum together but this must be done at least twice a year in order to conform to the requirements. The Council of 1956-57 has succeeded in meeting three times, a gratifying indication of their interest and sense of responsibility to their fellow members of the Institute.

In the intervals between the Council meetings, the business of the Institute has been conducted by the Executive Committee, comprising Council members from Ottawa, Montreal and Toronto (these are required to constitute a quorum) and any other members of the Council who may be able to attend. The Executive Committee has met six times. Copies of its minutes have been sent to all members of the Council and questions beyond the competence of the Committee have been referred to all members of the Council by mail.

On the whole, this system of administration has worked satisfactorily. However, with a growing number of Branches, it will become more and more difficult to obtain a quorum at any Council meeting, unless the existing requirements are modified. It is undoubtedly important that the present regional representation should be maintained; but it is equally important that the formation of additional Branches should not be discouraged because of the added difficulties which they impose upon the operation of the Council as at present constituted. It is submitted that, in the near future, consideration must be given to a compromise between these two claims.

COMMITTEES

The Council would like to express its thanks to the various Committees which have carried the responsibilities for the detailed work of the Institute during the year. Each will present its report later, but a few words about them, from the Council's point of view, would not be out of place in this report.

Finance

It has been the practice to appoint all the members of the Finance Committee from one Branch, so that they can meet without difficulty. This year the Committee, under the Chairmanship of Mr. R. J. Conrath, a member of the Council, has consisted of Mr. I. Manley, Mr. J. W. Truran and Mr. S. M. Weir, all of Montreal. While it must be admitted that, due to the generosity of Sustaining Members and the relative stability in the Headquarters organization, the Institute has enjoyed a year of fairly plain sailing through the usually troubled waters of finance, the Committee set its course and has held it with admirable steadiness and restraint. If adherence to a budget is a measure of a Finance Committee's competence, this year's Committee has done impressively and, as its report will show, has completed its term of office leaving the Institute in a sound and healthy position.

Admissions

In the past, and again in this last year, the members of the Admissions Committee have been appointed, one from each Branch; the purpose, of course, has been to ensure some uniformity of grading across the country. This arrangement necessitates the conduct of all business by mail; the applications are passed from member to member and each records his vote and comments on the grading of each applicant; the results are gathered together by the Chairman and ultimately submitted to the Council as recommendations.

G/C C. W. Crossland (Ottawa) served for the third year as Chairman of the Admissions Committee and Professor T. R. Loudon (Toronto) also served on the Committee for a third year. The other members appointed were Mr. W. B. Boggs (Montreal), Mr. H. H. Ollis (Vancouver), F/L J. J. Deslauriers (Winnipeg) and Mr. C. C. Young (Edmonton). No members were appointed from Cold Lake and Halifax-Dartmouth because these Branches were formed after the Committee was established and, in view of the already rather laborious procedure, it was deemed inadvisable to make the Committee any bigger.

After a good deal of discussion between the Council and the Committee, a recommendation has been put forward to next year's Council that henceforth the Committee should be appointed entirely from the members of the Ottawa Branch; it has also been recommended that G/C Crossland should be reappointed as Chairman. Sufficient experience has now been gained, particularly by G/C Crossland, to enable this change to be made, with some confidence that the grading can be carried out uniformly and impartially and certainly more expeditiously by a central Committee.

Despite the mechanical difficulties, the Committee has processed over 500 applications in the course of the year and has seldom taken more than three months about any one of them; and when one realizes that this three months includes the uncertain period needed to obtain replies from the References, this

flow-time does not appear unduly long. Every member of the Committee has studied the details of each application and formed an opinion about it; over so many applications this is a formidable amount of work, taking a great deal of the Committee members' time, and the Council is most grateful for their conscientious performance of this important duty.

Publications

Because the Publications Committee must work in close touch with the production of the Journal, this year's Committee was appointed, as before, from the members living in Ottawa. Mr. J. Lukasiewicz has been the Chairman and S/L W. M. McLeish, Mr. G. Glinski and Mr. A. H. Hall, have been its members; Mr. Hall replaced Mr. R. B. Ferris who served until he was transferred to Montreal in November.

This year, as the Committee's report will show, the Journal has paid for itself. There is every reason to believe that it will continue to support itself, independently of the Institute's general funds, so far as the actual printing and mailing is concerned; the time spent on it by Mrs. Ross and the Secretary is, of course, another matter.

In addition to the Journal, the Committee has been responsible for the production of the List of Members and of the Preprints, which are being provided for the first time at this Annual General Meeting. In the past, preprints available at C.A.I. meetings have been supplied by the speakers themselves. This practice is something of an imposition upon the speakers and clearly the Institute ought to produce its own. The Council, therefore, approved this innovation, though the Preprints must be sold at less than cost and the service is likely to prove rather expensive.

The Editorial Board should not be overlooked. In certain departments it has been kept fairly busy in studying and making recommendations about papers submitted for publication in the Journal. It deserves great credit for the standard which it has maintained.

Specialist Services

A new Committee was set up this year to study the needs of the specialist members of the Institute and to devise ways and means of serving them. Obviously the programmes arranged for Branch meetings and for the major meetings of the Institute must be broad in scope to satisfy the diverse interests of the membership at large but it was felt that the Institute should also provide for those members in specialist fields who wanted to go more deeply and specifically into their particular subjects. For example, some members had complained that they never found articles in the Journal which were of any direct benefit to them; others had suggested that the Institute should arrange symposia, at which the experts could get together for a day or two to discuss the finer points of their disciplines; and various ideas about the services to Student Sections had been put forward. It was to find answers to these problems that the Specialist Services Committee was set up. G/C H. R. Foottit was appointed as its Chairman and Mr. J. L. Orr, S/L O. B. Philp and Mr. R. J. Templin as its members.

Though much remains to be done in this difficult and important field, the Committee has made a very significant advance in developing the idea of Specialist Sections. These Sections are in effect societies of specialists set up within the framework of the Institute, using the Institute's facilities and financed by the Institute, but otherwise operating more or less on their own. By this means, specialists can evolve their own programmes – just as the Branches do – without dividing the aeronautical fraternity into several, small, independent but overlapping societies.

Only one such Section has been set up to date, namely the Test Pilots Section which was formally established in November. However, it seems likely that a Rocket Section will be formed soon and it is to be hoped that others will follow for such specialists as Aerodynamicists, Licensed Air Engineers, Electronic Engineers, Structures Engineers and the like.

Programmes

The Programmes Committee is responsible for two things. Firstly, it must devise the programmes of sessions at major Institute meetings and invite the speakers to address these sessions; secondly, it must render what help it can to the Branches and sometimes try to arrange that eminent speakers visiting Canada from abroad are given the opportunity to address several Branches while they are in this country. As can be realized, both these duties demand foresight, imagination and tireless energy; this year's successful programme is a tribute to all concerned. Mr. S. L. Britton has been Chairman of the Committee and the other members have been the Chairmen of the Branch Programmes Committees, Mr. G. C. Keefer of Montreal, S/L G. B. Waterman of Ottawa, W/C E. P. Bridgland of Toronto, Mr. R. N. McCullum of Vancouver, Mr. B. W. Torell of Winnipeg and S/L J. A. G. Diack of Edmonton. They have worked together admirably and the Institute is indebted to them for the enjoyable and varied fare which they have provided.

Not only has this Committee laid out the programme for this year – and, in so doing, had the new Mid-season Meeting to contend with – but it has done a good deal of planning for the coming year. In fact, the programme for the I.A.S./C.A.I. Meeting in the fall is already nearly completed and some thought has been given to the Mid-season Meeting and the Annual General Meeting of 1958. Undoubtedly the Institute must get into the habit of planning its programmes at least a year ahead and it has fallen to the lot of the 1956-57 Programmes Committee to handle its own year and to make some headway into the future.

HEADQUARTERS: I.A.S. AND R.Ae.S.

The Headquarters organization has remained the same throughout the year. The Secretary has made visits to all the Branches and to the Headquarters of both the I.A.S. and the R.Ae.S., the latter during a trip to England on personal business last summer.

It should be mentioned that the Institute's relations with its "progenitor" societies continue to be excellent. The Secretary makes no bones about referring to them whenever he is in doubt and their unstinted help and advice is most sincerely appreciated.

ORGANIZATION

Since the Annual General Meeting of 1956, two new Branches have been added; both are of special interest. The Branch at Cold Lake is situated at an R.C.A.F. Station; admittedly it is a big station and there are several Contractors' representatives living there, but there is no industry at Cold Lake at all. Its membership is not very great – between 30 and 40 – but it is steadily increasing, in spite of postings, and the Branch has run a full programme of monthly meetings throughout the season. It is doing good work and its establishment has been fully justified. The other new Branch is known as the Halifax-Dartmouth Branch; it is centred on Fairey Aviation and H.M.C.S. Shearwater but includes R.C.A.F. Station Greenwood within its orbit. This Branch, once started – and it was rather slow in getting started – is growing rapidly and is expected to develop into a very flourishing and useful member of the C.A.I. family. With its establishment in November, the Institute completed its chain of Branches "from sea to sea".

A noteworthy development of the year was the formation of the Test Pilots Section to which reference has already been made. It now has a membership of about 40. Unlike Branches, Sections have no geographical centres at which to hold their Annual General Meetings and so at each Annual General Meeting of the Institute, a session will be set aside for each Specialist Section; the Test Pilots will hold their Annual General Meeting this afternoon; they will have a business

period and then a technical paper will be presented. All members of the Institute and, in fact, any visitors registered for this Meeting are free to attend but, of course, only members of the Section may vote on any points of Section business.

Following the example set by the Toronto Branch in 1955-56, the Vancouver Branch has now fully developed the activities of a Student Section at the Canadian Services College, Royal Roads. The foundations of a Student Section have also been laid in Montreal, and the Ottawa Branch hopes to inaugurate a Student programme at the Royal Military College, Kingston, in the fall; preliminary discussions with the R.M.C. have already taken place. The growing interest in Student affairs is a healthy sign; they are an important facet of the Institute's work.

MEMBERSHIP

Membership of the Institute continues to increase in a most satisfactory manner. Although 104 members were lost during the year through death, resignation or non-payment of dues, the membership at the end of March stood at 1,822. This is a 24% increase over the figure at the end of the previous fiscal year.

At an Executive Committee meeting held on the 15th April and at yesterday's Council meeting, a further 198 members were admitted, so that the membership now stands at 2,020. At the last Annual General Meeting it was 1,542.

PROGRAMMES

Apart from the Branch programmes, all of which have consisted of monthly meetings held regularly since September, the Institute has held – or, after tomorrow, will have held – three major meetings during the year. The third joint meeting with the I.A.S. was held in Toronto on the 26th-27th November. It was a notable success, with a registration of over 640. For the first time the meeting was honoured by the presence of the President of the I.A.S. and it was a great pleasure to welcome Dr. Sharp in this capacity. The programme of papers was excellent and the second W. Rupert Turnbull Lecture was delivered on this occasion by Dr. Simon Ramo.

The first Mid-season Meeting was held in Winnipeg on the 25th-26th February. The proposal to hold this meeting was an amplification of the suggestion, already mentioned, that a meeting of the Council should be held outside the Ottawa - Montreal - Toronto triangle. The meeting included two technical sessions, directed chiefly at cold weather operations, and a tour of the Standard Aero Engine and Bristol Aircraft (Western) plants. It proved to be a promising prototype of future meetings of this sort, though in view of its experimental nature this year's programme was intentionally rather slender.

The third meeting of the year is this Annual General Meeting. The programme is a very attractive one, covering a wide range of subjects, and some very distinguished speakers are included. It is an honour to have Mr. Jones, the immediate Past President of the R.Ae.S., as the Speaker this evening.

With both Dr. Sharp and Mr. Jones attending the two principal meetings in the Institute's calendar, it has indeed been a memorable year.

1959

Special Meeting

It has been stated that the Programmes Committee has been working on plans for 1958. The Council has been giving some thought to 1959.

1959 will be the 50th anniversary of flight in Canada and as such it will be a year of great significance to Canadian aviation. It would seem to be appropriate to hold a Special Meeting of the Institute to mark the occasion and some suggestions for this Special Meeting have been discussed.

Silver Dart

Another proposal for 1959, which was put forward by Mr. L. A. J. Pelland, is that the C.A.I. should arrange for the construction of a full-scale replica of the Silver Dart, the aircraft in which Mr. J. A. D. McCurdy made his historic flight nearly fifty years ago. Mr. Pelland pointed out that drawings and a good deal of information on the aircraft were still available from the Smithsonian Museum, the National Geographic Society and other sources, and he suggested that the Sustaining Member Companies of the Institute should be invited to make or supply parts and components, working from this data; by present-day standards the work would not be very complex and, if enough Companies were prepared to co-operate, no very heavy burden would be imposed upon any one of them.

A Committee was set up, under the Chairmanship of Mr. M. S. Kuhring, to study the feasibility of this suggestion. After consulting a few of the major Companies and receiving an encouraging response from each, the Committee reported to the Council that the plan seemed to be practicable. Accordingly, the Committee was instructed to proceed with a preliminary break-down of the work to be done and, at the same time, the proposal was placed before all Sustaining Members by letter. That was early in May and from the replies received to date it would seem that actual construction can begin as soon as Mr. Kuhring is ready to give each Company its assignment.

Even so there is not much time to be lost if the project is to be completed by 1959. Members will be familiar with the delays and frustration which are inherent in the manufacture of aircraft and there is no reason to believe that the Silver Dart will prove to be an exception. The job must proceed at once, undaunted by the fact that no one has yet suggested where the aircraft can be kept when it is finished!

EDUCATION AND TRAINING

At the conclusion of its term of office, the Education and Training Committee of 1955-56 recommended that the Institute's work in the field should be broadened and that the help of local Committees at the Branches should be invoked. After some deliberation, however, the Council decided that the Institute's educational and training activities should be set up on a Provincial rather than on a Branch basis and accordingly Committees were appointed in British Columbia, Alberta, Manitoba, Ontario, Quebec and Nova Scotia – all Provinces having some concentration of C.A.I. members. The central Committee was done away with and each of these Provincial Committees was placed under the direct control of the Council; Mr. R. B. McIntyre was appointed as the member of the Council responsible for coordinating and guiding their endeavours.

Although no central Committee has existed, the Chairmen of the Provincial Committees or their representatives have met on three occasions under the Chairmanship of Mr. McIntyre to exchange views and to discuss common problems. These meetings were held in Toronto on the 25th November, in Winnipeg on the 24th February and here in Ottawa yesterday. Members of the Council, Branch Chairmen and others directly interested have always been invited to attend.

The work of these Committees would fill a report in itself; it can only be summarized here. Briefly, they have been in touch with Provincial educational authorities, local industry, parent-teacher groups and others, in an attempt to arouse interest in the pressing needs for technical manpower in the aviation business generally, and to devise methods for meeting these needs. Attention has been particularly directed at the sub-professional level where the demand appears to be greatest.

The shortage in this sub-professional level, variously called the technologists or technicians, is being felt in all branches of engineering and the C.A.I. is working closely with such organizations as the E.I.C. and the Industrial

Foundation on Education, which have become vitally interested in the subject. In fact, having started its investigations early in 1955, the C.A.I. is somewhat ahead of the others in information and organization.

A tremendous amount of work is yet to be done; the surface has barely been scratched. But progress is being made and the Institute is playing a leading part in the national effort.

It would take too long to present the reports of the Provincial Committees at this meeting but the Council would like to express its thanks to the Committee Chairmen – Mr. J. A. Gillies of British Columbia, Mr. W. A. B. Saunders of Alberta, Professor C. M. Hovey of Manitoba, Professor T. R. Loudon of Ontario, Mr. R. H. Guthrie of Quebec and Mr. E. C. Garrard of Nova Scotia. Their contributions have been most valuable.

AWARDS

The McCurdy Award continues to attract wide interest and this year 12 nominations were submitted to the Selection Committee. The Committee found that their task was not an easy one but they eventually chose a winner, whose name will be announced when the Award is presented at the Dinner this evening.

As already stated, Dr. Simon Ramo was invited to deliver the W. Rupert Turnbull Lecture for 1956. His lecture, entitled "The Guided Missile as a Systems Engineering Problem", was a masterly discussion of this new branch of aeronautical engineering and aroused the greatest interest.

Thirdly a new award has been introduced at the suggestion of G/C Foottit. It will be known as the F. W. (Casey) Baldwin Award and will be presented at each Annual Dinner to the author of the best paper published in the Journal during the preceding calendar year – that is from January to December. The winner is selected by the Council, after an initial screening by the Publications Committee. This award will be presented for the first time at the Dinner this evening, at which time the name of the 1956 winner will be announced.

ELECTION OF FELLOWS

Each year the Council is charged with the election of Fellows, from nominations submitted by individual members of the Council or by four of the existing Fellows. To be elected to this highest grade of membership, a member must have been an Associate Fellow for at least one year and must have attained considerable distinction in aeronautical science or engineering. The process of nomination and election is long and highly selective. The Fellows elected this year are:

Mr. Winnett Boyd
Mr. E. K. Brownridge
Mr. F. H. Keast
Mr. M. S. Kuhring
Mr. R. N. Lindley
Admiral L. B. Richardson, and
Dr. T. P. Wright

HONORARY FELLOWS

It is a pleasure to announce that the Council has appointed Mr. M. E. Ashton and Mr. W. F. English Honorary Fellows of the Institute.*

*This was announced at the Annual Dinner on the 27th May.

NEW COUNCIL

Yesterday the retiring Council held a joint meeting with the newly constituted Council for 1957-58. Because the members of the Council serve for two years, so arranged that half of them retire from office each year, a new Council always includes newly elected members and members who have already served for one year; the result is a happy mixture of new ideas and experience in office.

The new Council has elected its President and Vice-President in accordance with the By-laws and the Council for the coming year is, therefore, as follows:

President–G/C H. R. Foottit
Past President–Mr. T. E. Stephenson
Vice-President–Mr. S. L. Britton

Councillors–
Mr. R. B. McIntyre (Toronto)
Mr. P. B. Dilworth (Toronto)
Mr. F. M. Hanna (Toronto)
Mr. R. J. Conrath (Montreal)
Mr. A. E. Ades (Montreal)
Mr. T. A. Harvie (Montreal)
Mr. J. L. Orr (Ottawa)
Mr. A. T. Gilmour (Vancouver)
Mr. R. N. McCollum (Vancouver)
Mr. H. W. Grant (Winnipeg)
Mr. W. E. Robinson (Winnipeg)
Mr. C. C. Young (Edmonton)
S/L J. E. Moran (Edmonton)
Mr. D. L. Wallis (Cold Lake)
W/C W. N. Hoye (Cold Lake)
CDR E. B. Morris (Halifax-Dartmouth)
LCDR J. C. Sloan (Halifax-Dartmouth)

The retiring Council wishes them well and assures them that they have an interesting and rewarding year ahead of them.

Report of the Finance Committee 1956-57

As the President has already mentioned, the Finance Committee had very little difficulty in maintaining the Institute in a position of solvency during the last fiscal year. Even the budget was comparatively easy to prepare inasmuch as there were only two major variables to contend with, these being membership and publications. We were fortunate in predicting the figures for these two variables fairly accurately so that the budget and the financial statement are in very close approximation to each other. At this point I would refer you to the Auditor's Financial Statement (*appearing on pages* 248 *and* 249.–Sec.).

The most interesting figures in the statement which I have just referred to are those which pertain to publications revenue and expense. You will have noted that revenue exceeded expense by approximately $3,000. This, as you can see, indicates a very healthy condition although it does not provide for the salary of the Journal Editor nor for overhead which might be assigned to these particular operations. Your Finance Committee has recommended to the Council that the Journal operations be accounted for separately. We believe that every effort should be made to put this publication on a self-supporting basis and, while we must admit that it would be worthwhile to continue publishing the Journal even at a loss since it is one of the main membership benefits offered by the Institute, we do feel that, by accounting for it separately, a better control can be maintained to ensure that it remains self-supporting and, perhaps, even profitable.

In the early days of the Institute, it was recommended that we endeavour to establish a reserve sufficient for one year's operation. Since this goal is not far away your Finance Committee has recommended to the Council that the matter of sustaining membership fees be

reviewed in the light of anticipated expense over the next four or five years. In other words, it has been suggested that the Council endeavour to draft a program covering this period of time which would include all those projects which would seem desirable or necessary for the wellbeing of the Institute and its members so that an estimate of the amount of money required to carry the program through can be prepared. With these figures as a starting point, we could then determine the amount of support needed from sustaining members and a classification for their fees could be established. The Finance Committee has recommended that this classification be established along the lines of that used by the Air Industries and Transport Association of Canada. In the opinion of your Finance Committee, sustaining members would prefer a fee classification arrangement to the voluntary system now in operation.

One of the projects completed by your Finance Committee this year was a health and retirement plan for the Secretary. This matter, unfortunately, did not come up for discussion at the last Committee meeting but it would be my personal recommendation that this plan be extended and offered to other members of headquarters staff who have given indication that they are likely to remain permanently in the employ of the Institute.

In conclusion, I would like to thank the members of my committee, who have already been mentioned in the President's report, for the contributions which they have made. It so happens that the majority of our meetings were through correspondence or the telephone but, since we had no major problems to solve, this system worked pretty well. Our final meeting was personal, however, and it was at this meeting that the above-mentioned recommendations came forth. We earnestly hope that the new Council and the new Finance Committee will give serious consideration to them.

AUDITORS' REPORT

To the Members,
Canadian Aeronautical Institute,
Ottawa, Ontario.

We have examined the accounting records of the Canadian Aeronautical Institute for the year ended March 31, 1957, but we did not make a detailed examination of all the transactions in the year.

Subject to the foregoing, in our opinion, the following balance sheet and related statement of revenue and expenses have been drawn up so as to show the true and correct view of the financial condition of the Canadian Aeronautical Institute as at March 31, 1957, and of its operations for the year ended on that date, according to the best of our information and the explanations given to us and as shown by the books.

ARMSTRONG, CROSS & CO.,
Chartered Accountants.

OTTAWA, Ontario,
May 1, 1957.

Statement 1

CANADIAN AERONAUTICAL INSTITUTE
BALANCE SHEET
As at March 31, 1957

ASSETS

Current:			
Cash on hand and in bank		$23,564.14	
Accounts receivable		2,319.84	
Dominion of Canada bonds 3% due September 1, 1956	$ 7,276.87		
Hydro Electric Power Commission bonds 3½% due March 1, 1977	11,970.00		
		19,246.87	
Inventory of lapel pins on hand for resale		299.88	
Accrued interest on bonds		53.75	
			$45,484.48
Fixed:			
Furniture and fixtures		2,952.92	
Less: Accumulated depreciation		997.06	
			1,955.86
			$47,440.34

LIABILITIES AND SURPLUS

Liabilities:			
Accounts payable and accrued charges		$ 3,759.30	
Fees received in advance		2,729.00	
Journal subscriptions received in advance		994.50	
			$ 7,482.80
Surplus:			
Balance — March 31, 1956		20,113.40	
Add: Adjustments in revenue for the year ended March 31, 1956	$ 680.85		
Net revenue for the year — per Statement 2	19,163.29		
		19,844.14	
			39,957.54
			$47,440.34

STATEMENT OF REVENUE AND EXPENSES

For the year ended March 31, 1957

Revenue:			
Fees — Regular	$ 7,384.75		
— Entrance	1,705.00		
— Sustaining	32,720.00		
		$41,809.75	
Grants:			
Institute of the Aeronautical Sciences	1,000.00		
Royal Aeronautical Society	1,000.00		
		2,000.00	
Investment revenue:			
Bond interest	591.98		
Bank interest	220.55		
		812.53	
Publications revenue:			
Journal subscriptions	4,093.12		
Advertising	16,385.68		
Sundry technical papers	250.17		
		20,728.97	
Dinners, meetings, receptions		1,994.97	
Lapel pins		108.00	
Insurance premium refund		10.24	
Total Revenue			$67,464.46
Expenses:			
Remissions to branches:			
Standard allowances	$ 2,932.00		
Special allowances	37.77		
		$ 2,969.77	
Publications expense:			
Journal	16,819.50		
Sundry technical papers	1,114.29		
		17,933.79	
Dinners, meetings, receptions		39.59	
Meetings, printing		370.96	
Prizes and donations		443.25	
Membership routine		432.48	
Salaries, permanent staff		16,433.14	
Staff benefits		718.09	
Part time help		43.50	
Rent		2,760.00	
Telephone		489.51	
Maintenance of equipment		21.30	
Office supplies		2,927.93	
Travel		1,591.01	
Exchange and bank charges		168.88	
Legal and professional fees		465.00	
Miscellaneous		4.00	
Depreciation expenses		488.97	
Total Expenses			48,301.17
Net Revenue for the Year to Statement 1			$19,163.29

Report of the Admissions Committee 1956-57

The Admissions Committee for 1956-57 was constituted as follows:

G/C C. W. Crossland (Ottawa) Chairman
Professor T. R. Loudon (Toronto)
Mr. H. H. Ollis (Vancouver)
Mr. C. C. Young (Edmonton)
F/L J. J. Deslauriers (Winnipeg)
Mr. W. B. Boggs (Montreal)

During the year under review the Committee agreed on a paper, "Policy Guidance to Committee on Admissions", which was approved in substance by the Council. This paper is an attempt to crystalize the experience of the last three years and is intended to serve as a guide for future Committees on Admissions.

The procedure followed by the Committee is the same as that described in last year's Annual Report. With the exception of Students, the applications are circulated to all Members of the Committee by mail and each Member votes on the grading of every candidate. For the past three years the Admissions Committee has been composed of the Chairmen of the Branch Membership committees, who were in turn appointed by the Chairmen of the Branches. The Chairman of the Admissions Committee was appointed by the President from among members of the Committee. During the past year, Regulation No. 11 has been amended and now states that the President, in consultation with the Council, shall appoint the Admissions Committee.

With the continued growth in the membership of the C.A.I. and the formation of new Branches this year at Cold Lake and Halifax, the Admissions Committee agreed that their present organization was too cumbersome and that the Committee should be reduced in size. After obtaining the views of the other members of the Committee, the Chairman proposed to the Council that the Committee be composed of three members of Associate Fellow or Fellow grade located in Ottawa, with the Secretary of the C.A.I. serving as Secretary of the Committee. It was also proposed that the Admissions Committee would obtain a reference from the Chairman of the Branch to which a candidate would belong, if admitted, or from a member of that Branch of Associate Fellow or Fellow grade appointed by the Chairman for that purpose. However, some Branches do not consider this necessary. It is believed that the reorganization of the Admissions Committee on the lines proposed would speed up its work considerably. Since the last annual meeting the Committee has made nine reports to the Council and the number of candidates recommended for admissions to each grade is as follows (last year's figures are in brackets):

Associate Fellow	24	(31)
Member	263	(195)
Associate	24	(17)
Technical Member	151	(156)
Technician	17	(13)
Student	109	(89)
	588	(501)

The Committee votes were tied in seven cases, which were referred to the Council for decision. Seven members were recommended for advancement in grade to Associate Fellow, eighteen to Member, eleven to Technical Member and two to Technician. Thirteen other applications for advancement in grade were not recommended. In addition, twenty-seven applications are now being processed and eighty-six are waiting for reference forms to be returned, or to be considered by the new Committee.

The continued rate of increase in membership is very gratifying, especially to those who undertook the onerous task of organizing the Institute. There seems every reason to be confident that the C.A.I. will continue to grow in membership and that it will receive increasing public recognition.

Report of the Publications Committee 1956-57

The production of the Journal, which has been the main preoccupation of the Publications Committee in the past years, has become more of a routine operation in its technical aspects and the Committee was therefore able to give more attention to other matters, such as development of new sections in the Journal, broadening of the scope of the Editorial Board, production of preprints and of an improved List of Members, promotion of the Journal as an advertising medium etc.

THE JOURNAL

In last year's report of the Publications Committee a satisfactory development of the Journal was predicted on the basis of the first full year of operation. The figures for the year under review appear to justify fully these hopes. The circulation of the Journal has been increasing, as indicated below, at an average rate of 40 per issue and has reached 2,227 in March, 1957:

April, 1955 – 1,300
March, 1956 – 1,826
March, 1957 – 2,227

Financially, as discussed later in detail, the Journal, including the List of Members, has been self-sustaining.

Material

Although the supply of material submitted for publication was by no means over-abundant, the situation in this respect has improved somewhat compared with the previous year, both as regards volume and variety. Perhaps a better balance between highly specialized and general interest papers was achieved and it is hoped that, if this trend prevails, it will be possible to improve still further the quality of the contributions to the Journal.

Editorial Board

With the development of the Journal the members of the Editorial Board were more frequently called on to assist the Publications Committee with the selection of papers and the Committee wishes to express its thanks to the Editorial Board for their valuable contribution in maintaining the standard of the Journal.

It was found desirable to extend the scope of the Editorial Board and the field of Design was introduced in September, 1956.

Book Reviews and Technical Forum

The Book Reviews and Technical Forum sections of the Journal, although introduced in the previous years, have been appearing more frequently this year.

Review copies of books are being regularly received from major technical publishers and distributed by the Secretary for review to members of the Editorial Board. The Committee believes that this is a useful service to the readers of the Journal.

The Technical Forum section appeared twice during the last year. The Publications Committee would like to encourage readers of the Journal to make use of the Technical Forum for publication of brief technical contributions and discussion of papers.

TECHNIQUE OF PRODUCING THE JOURNAL

In the past year the Publications Committee has been relieved of the numerous and tedious duties connected with the preparation of material for the printer. As experience accumulated and the supply of papers was more plentiful, this has become a matter of routine procedure and the Committee is indebted to the Secretary, Mr. H. C. Luttman, and his Assistant, Mrs. G. G. Ross, for performing this work.

LIST OF MEMBERS AND PREPRINTS

For the first time, this year a printed List of Members was published and Preprints are being provided at the Annual General Meeting. Although financially both these items represent considerable expenditures, they are regarded as necessary services to the membership and the authors.

ADVERTISING

The revenue from advertising in the Journal has very nearly doubled this year, with 28 advertisers compared with 20 last year. Although this in itself might be regarded as satisfactory progress, the Publications Committee feels that further improvement is possible and necessary. In particular, the Committee recommends that improved C.A.I. Circulation Statements, showing subscription analysis by business and job assignment, should be prepared and distributed to the potential advertisers; that a brief, graphically attractive pamphlet be prepared, clearly indicating the development of the Journal and the value of its reader audience to the advertisers; that improved advertising rate cards be introduced. The Committee feels that it could not devote enough effort to these problems and therefore recommends that an Advertising Sub-committee of the Publications Committee be appointed by the Council.

The Committee had the benefit of extensive discussions on the subject of advertising with Mr. J. Ryan of the I.A.S., who came to Ottawa in January, 1957. The Committee wishes to express its thanks to the I.A.S. for their valuable help and cooperation on this and many other occasions.

FINANCE

The Publications revenue and expenses for the previous and present years are compared above.

	1955–56 $	1956–57 $	% Increase
Revenue			
Journal subscriptions	2,804.36	4,093.12	46
Advertising	8,432.49	16,385.68	94
Sale of reprints and preprints	383.50	250.17	−35
Total	11,620.35	20,728.97	78
Expenses			
Production and distribution of Journal	12,816.13	16,819.50	31
List of Members	1,007.00	933.54	−7
Preprints and reprints	341.70	180.75	−47
Total	14,164.83	17,933.79	26
Balance	**Loss 2,544.48**	**Gain 2,795.18**	

While expenses have been increased by 26%, revenue has been augmented by 78%, which resulted in a surplus of $2,795.18 compared with a loss of $2,544.48 last year. Perhaps most significant is the increase in advertising revenue, which has almost doubled, while the cost of the Journal production and distribution has been increased by only 31%.

CONCLUSION

The Committee believe that in the past year the publications of the Institute have developed satisfactorily, with regard to reading material, service to members, circulation and cost.

The Canadian Aeronautical Journal is becoming a well known publication in the aeronautical circles at home and abroad and there is every hope that this trend will continue. With the burden of preparation of material for the printer removed, the Publications Committee, assisted by the Editorial Board, is able to concentrate on review and selection of papers and other editorial duties to insure the standard of the Journal is maintained and improved. The revenue from advertising in the Journal has almost doubled this year and the Publications Committee recommends that this source of support for the Journal should be further developed and exploited and that an Advertising Sub-committee of the Publications Committee should be appointed to undertake this task.

Report of the Specialist Services Committee 1956-57

The Specialist Services Committee was organized by the 1956-57 Council at their first meeting last year. The purpose of the Committee is the "examination of the proposal to set up Specialist Sections and the submission of recommendations on this and other means of serving specialist members of the Institute." Members of the Committee are G/C H. R. Foottit, Chairman, J. L. Orr, R. J. Templin and S/L O. B. Philp.

The Committee met twice during the year. It reviewed the proposal for Specialist Sections which had been previously submitted to the 1955-56 Council. It investigated an alternate Specialist Committee structure. However, it finally recommended the Specialist Section organization which we now have and submitted to the Council suggested C.A.I. and Section regulations. The Council approved the Committee's recommendations and one Specialist Section, the Test Pilots, has now come into being.

Considering that this was a large step forward, the Committee did not look into any other means for serving specialist members of the Institute last year. However, plans are being made for further meetings in 1957-58, so that other steps can be considered.

Report of the National Program Committee 1956-57

The National Program Committee is comprised of a representative from each Branch in the person of the Branch Program Chairman with the co-ordination and, I hope, the incentive being supplied by the National Program Chairman. During the past year the Committee was concerned with the following activities and I would like briefly to give a few details of our operation under these headings.

Programming the Major Meetings

This includes setting up the program and suggesting to Council the theme of the major meetings and recommending the speakers and session chairmen. In all, arrangements were made for thirty-five papers and speakers to be given in the three major meetings; the joint IAS/CAI Meeting, the Mid-season Meeting and the Annual General Meeting. Of these papers, seven were supplied by U.S. speakers and two were from the United Kingdom.

It is to be noted that this year's program inaugurated several new features. Firstly, the introduction of the Mid-season Meeting and, secondly, an attempt was made to set aside at least one session for specialist groups at each of the major meetings. A further modification to this latter approach has been made by the introduction of a "paperless" session which we will be attempting for the first time at this Annual General Meeting. An attempt has been made to keep papers as topical as possible and of interest to the majority of members across the country. The Committee has already submitted the theme and the suggested papers to Council for the IAS/CAI Meeting to be held next October.

Improvement of Branch Program Activities

An attempt has been made to suggest speakers for the various Branch programs and, in some instances, assistance has been given to smaller Branches in making arrangements for the extension of speaker tours beyond the Toronto, Ottawa, Montreal circuit. The bringing about of the Mid-season Meeting, I feel, will do a great deal to improve the flow of speakers to Western Branches during the regular season.

It will be of interest to note that a total of 93 technical papers were given by speakers to the members of the C.A.I. across Canada during the past year.

Film List

An attempt was made through all Branch Chairmen to obtain as complete a Canadian film list as possible and to try to establish a routine for keeping the Secretary, Mr. H. C. Luttman, informed of the additions to the list as the films become available in the areas controlled by the Committee. As a reciprocal action a bibliography is to be published of Canadian aviation films which will be supplied to all Branches and kept up to date by Headquarters.

In reviewing Mr. Schaefer's comments in his National Program Committee Report for 1955-56, he outlined that one of the main difficulties was to get Council to take an active interest in the planning of the major programs. I would like to report that this was at no time a difficulty this year and that I found Council most willing to comment and make suggestions on any programs that were placed before them.

As mentioned in my summation of activities for this year and as recommended in Mr. Schaefer's report of last year, I believe that everything possible was done on a national basis in an attempt to provide speakers to outlying Branches and to encourage smaller Branches to greater efforts. These efforts went so far as to attempt to establish a close informal working arrangement directly with IAS Sections which were located near some of our Branches.

Another point which was brought out in last year's report was the "great bulwark of strength" that Charles Luttman is in all program matters. I would like to add my plaudits to those of Mr. Schaefer's as I found our Secretary a wonderful assistance in the past year.

The last recommendation which Mr. Schaefer made was that of forming a National Program Committee within the Branch of the National Chairman so as to assist him in his activities and to give him solace in his hours of desperation. I am afraid that I did not go along with this suggestion as I have found that it is difficult enough to lay down a continuously organized approach to the matter of programming without having to ask opinions each time a step is carried out. I feel that the constant review of the program at each of the Council meetings affords the control necessary to keep program activities in hand.

Looking back over the activities of the past year I can only hope that a little has been added to establishing the "terms of reference" for the National Program Chairman's job. The only discouraging aspect of the entire operation is the need for greater forward planning in view of the complexity of setting up accommodation and papers for the major meetings. However, I feel this can be readily countered by continuous planning and a more active participation by the Branch Chairmen in providing suggestions and papers for use in the major meetings. I would like to once again express my appreciation for the assistance given by Mr. H. C. Luttman and the Council as a whole in arranging this year's activities.

BRANCHES

NEWS

Toronto

Student Thesis Competition

The annual Student Thesis Competition of the Toronto Branch was held on the 6th March in Hart House, University of Toronto. The winners were

First – Mr. D. R. Madill
Second – Mr. G. G. Jacquemin
Third – Mr. A. J. Reynolds

The prizes were presented at the Annual General Meeting of the Branch on the 29th April.

Winnipeg

Reported by D. C. Marshall

April Meeting

The installation of the 1957-58 Executive of the Winnipeg Branch was made at a dinner meeting held on Tuesday, 30th April.

Mr. D. A. Newey, retiring Councillor, was the Meeting Chairman. In opening the meeting, he thanked the outgoing Executive for their services. The Winnipeg Branch, during the past year, has grown to over 100 members and 14 applicants, representing 12 companies. A successful 1956-57 season had included five technical meetings, social gatherings and the C.A.I. Mid-season Meeting.

Mr. Newey thanked those who had allowed their name to stand for election to the new Executive and welcomed them to office. Professor Hovey thanked Mr. Newey on behalf of the new Executive and expressed the hope that they would carry on as successfully as had their predecessors.

Two guests from the Toronto Branch, Mr. I. M. Hamer and Mr. R. B. McIntyre, were then introduced by Mr. Newey. Mr. McIntyre thanked the Branch for the invitation to be present at the meeting. He mentioned his position as National Councillor for Education of the C.A.I. and some of the problems of which he and others were becoming increasingly aware. The main problem appears to be a shortage of technicians and technologists. Efforts are being made by means of talks, a career film and written material to encourage technically adept students and others to enter the aeronautical field as a career.

At the close of the meeting, the members enjoyed a film, "Speaking of Air Power", by the courtesy of Bendix Eclipse and Aviation Electric, Montreal.

May Meeting

The May Meeting of the Winnipeg Branch was held on the 21st May in the Westinghouse Auditorium. The speaker was Mr. W. H. Gibson, Assistant Chief of Advanced Products, Orenda Engines Ltd., whose subject was "Philosophy of Gas Turbine Aero Engine Development".

Mr. Gibson first reviewed the present state of the art of engine design and stated that turbine engines are, at this time, at the same stage of development as piston engines were prior to World War II. He described the early types of turbine engines and discussed in detail the interdependence of compression ratio and specific fuel consumption, placing a practical limit on the former of 12:1. The turboprop engine, he said, will undoubtedly replace the piston engine in the near future because of equivalent or better fuel consumption and smaller frontal area and specific weight. In the case of jet engines, the design is more complex when one strives to obtain the most efficient product. He spoke of the advantages of the use of titanium for compressor blades and discs, giving figures showing a reduction of stage weight from 77 to 39 lb. This, of course, results in further weight saving by use of lighter shafts and bearings. He went on to discuss the advantages of two spool engines and some of the problems associated with part throttle operation of them. In speaking of the future, Mr. Gibson gave some interesting comparisons of conventional fuels with pentaborane and hydrogen. He also pointed out the difficulties attendant to atomic powered flight, in particular the low temperature required to accommodate a heat exchanger which, in turn, gives low efficiency. He closed his lecture with a discussion of the ranges of conventional aircraft, ramjets and ballistic vehicles, indicating that much development is necessary before the range of the conventional aircraft is exceeded.

Mr. E. L. Bunnell, Vice-Chairman of the Branch, thanked the speaker.

Edmonton

Reported by C. W. Arnold

May Meeting

The Edmonton Branch held its May meeting on Tuesday, the 14th, in the RCAF Officers' Mess, RCAF Station Namao, at 8.00 pm; 44 members attended.

Mr. C. C. Young presided in the absence of our Chairman, W/C J. G. Portlock.

A tour of the Station was made prior to the lecture, by kind permission of our Vice-Chairman, G/C J. R. Frizzle. This tour was much appreciated by all the members, who were able to inspect Javelin and Beverly aircraft.

Mr. Young gave the results of the ballot for the election of the new Executive Committee. He then turned over the meeting to the new Chairman, S/L J. A. G. Diack.

S/L Diack introduced the guest speaker, S/L R. D. Sloat of CEPE, who presented a paper on "Cold Weather Operation of Aircraft".

S/L Sloat introduced his talk by describing icing conditions on the ground. When on the ground, aircraft will frequently be found covered with a layer of frost. No matter how small or unimportant this may appear, it should always be removed, particularly in the vicinity of the wing tips. The simplest method of removal is by sweeping with a stiff broom; in emergency, evergreen branches can be used.

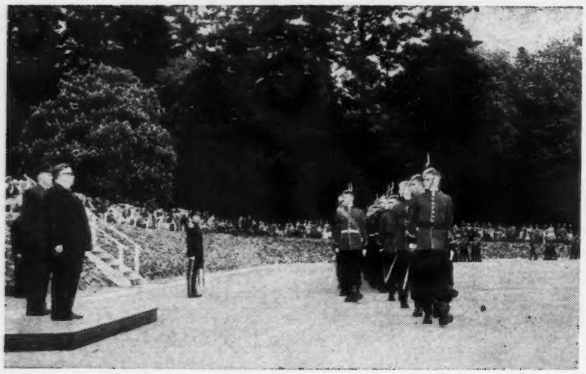
When aircraft are to be parked in the open, covers should be used for wings, tail unit and engine. These may be made of light material and should be white in order not to absorb heat and thereby melt any snow which may accumulate on them. All covers must, of necessity, be well fitted in order to prevent the entrance of snow. Adhesion of dry frost may be reduced by application of suitable paste or spray.

The speaker discussed at some length the maintenance of aircraft under cold weather conditions.

Aircraft can be and are maintained under conditions of extreme cold without shelter being available. Such operations are naturally uncomfortable for the crew and require a certain amount of originality and common sense if they are to get the job done and avoid frost bite.

Simple wind break screens give protection to ground crew when working and speed up maintenance work. For the purpose of protecting crews working on engines installed in aircraft, mobile screened decks which surround engine and nacelle give good workshop facilities, light, heat and protection from wind.

Two main methods of engine starting are employed in winter. The first is by the supply of external heat to the en-



The Hon. Ralph Campney taking the salute at the Royal Roads Graduation ceremonies. Cadet M. W. Stedman at the head of the column was Chairman of the Student Section during the past year.

At the Vancouver Golf Social. Front row (l to r) J. Hutton, H. Horne, R. McCollum. Middle, I. A. Gray. Back row (l to r) A. Coutts, J. Gardner, A. Bingham, R. Jubinville, W. Van Horne, D. O'Toole.

gine, generally by a Herman Nelson heater, but in emergency other types of portable oil heaters or even small wood stoves may be employed. The second and newer method of engine operation in cold weather is the use of the oil dilution system. Briefly, this consists of diluting the engine oil with gasoline obtained from the fuel system until the oil is sufficiently thin to permit free movement and adequate lubrication of the engine under the lowest temperatures expected.

Summing up, the speaker said that there are problems associated with severe icing which still need more satisfactory answers, such as de-icing of surfaces on an aircraft which has stood in freezing temperatures for long periods. Personnel clothing is generally satisfactory as is the warming-up of engines by external heat systems. Covers for aircraft are fairly satisfactory, but precautions must be taken when installing these.

Following a lively discussion period, S/L Sloat was thanked by S/L Diack and the meeting was adjourned.

Vancouver

Student Section May Meeting

On the 7th May, the Royal Roads Student Section of the C.A.I. met in the Reference Library of the Grant Block to hold an election of officers for the oncoming year 1957-58. In the absence of the Chairman, Cadet M. W. Stedman, Cadet L. C. Cook presided over the meeting. The minutes of the previous meeting were adopted as read by the Secretary, Cadet A. O. Manson.

Elected to office for the new term were:

Chairman–Cadet R. J. G. A. Houston
Vice-Chairman–Cadet P. Scholz
Secretary–Cadet R. J. Lawson

The graduating Executive expressed the wish that the new Executive expand the interest in the C.A.I. in the college and continue the attempts to have Mr. Tex Johnson, Test Pilot for the Boeing Aircraft Company, address the Cadet Wing. The new Executive then wished the graduating Executive the best of luck in furthering their studies at the Royal Military College in Kingston and expressed the hope that they would continue to take an active part in the C.A.I. Student Section there.

The meeting was adjourned to close the Royal Roads Student Section activities for the year 1956-57.

Graduation Ceremony

Reported by R. J. McWilliams

The Vancouver Branch was honoured to receive an invitation to attend the Graduation Ceremony of the 1955 Class at Royal Roads on the 10th May and was represented by the Secretary, Mr. R. J. McWilliams.

Nine C.A.I. Student members were in the Graduating Class and among the top-ranking Cadets presented with honours and awards were:

The H. E. Seller's Telescope –
Cadet M. W. Stedman
First class Subject Prize –
Cadet M. W. Stedman
Cadet G. C. Hopp
Cadet R. J. Lawson

After summer service and vacations, the graduating Cadets pass on to R.M.C. Kingston for a further two years of study. It is anticipated that they will join their fellow C.A.I. Students in the Student Section there.

The Graduation ceremonies were if anything a little more spectacular this year. The pre-war R.M.C. tradition of scarlet tunics for the Senior Class was revived and they were impressive.

May Meeting

Reported by R. W. Van Horne

On Thursday, 16th May, a 9-hole Golf Social was held at Peace Portal Golf Course to wind up the Vancouver Branch activities for the year.

After 9 holes of fun and frustration, we gathered at the clubhouse for coffee and sandwiches and the awarding of prizes. Among the prizes was a sportsman certificate and medal for the lowest medal score to Mr. J. Hutton and a crying towel to Mr. I. A. Gray for the highest medal score.

After listening to lots of golfers' excuses, the assembly broke up at 9.30 pm.

Cold Lake

Reported by F/L L. S. Lumsdaine

June Meeting

The astounding scope, speed and flexibility of modern pulse transmission and digital computation techniques as applied to the TACAN/DATA LINK system of air traffic control were the highlights of the June meeting of the Cold Lake Branch of the Canadian Aeronautical Institute. The final meeting of the current season was convened in the Library of the Sergeants' Mess on June 18th by the Chairman, W/C R. D. H. Ellis.

Mr. W. Haynes of the Hughes Aircraft Company, the speaker of the evening, discussed briefly some of the common building blocks of "Avionic" equipment. These ranged all the way from common vacuum tubes to transistors, magnetic amplifiers and electromechanical servo systems. As background for the discussion on TACAN, one of the latest navigation and traffic control systems, Mr. Haynes reviewed the basics of World War II LORAN and its modern, more sophisticated automatic version, CYTAC.

An outline of the technique by which TACAN provides the pilot and the ground control station with range and bearing, transmits altitude and airspeed information for ground control while simultaneously passing instructions, queries and acknowledgments between an aircraft and the ground control centre for as many as 126 separate aircraft in the space of three seconds, proved to be a fascinating demonstration of the fabulous speed of pulse and digital coding system techniques.

A Hughes Aircraft film in full colour and sound, covering industrial research and development, followed the lecture. The film featured the Company's top scientists describing and demonstrating a few of the recent electronic marvels from our familiar CF-100's MG-2 Fire Control System to a cathode ray tube with a memory which can be used to display remotely transmitted messages in printed form.

The final presentation of the evening was a short film by the Handley Page Co. dealing with the aerodynamic logic which resulted in the sonic "Crescent" wing form as developed for the VICTOR jet bomber. The development discussion was capped by a demonstration and explanation of the unique landing characteristics of the aircraft. It showed how the VICTOR actually lands itself, flaring out smoothly from its glide path as it nears the runway and settling smoothly onto the runway without a hand being put on the stick.

While further monthly meetings are not planned until September, the Branch is planning a social evening during the summer.

MEMBERS

NEWS

J. N. Dykshoorn, M.C.A.I., has resigned from his position with Jarry Hydraulics to take up a post as Stress Analyst with Boeing Airplane Co., Seattle.

S. R. Leake, M.C.A.I., formerly employed by Canadair Ltd., has moved to Seattle where he has taken a post as Design Engineer with the Boeing Airplane Co.

J. L. McKelvie, M.C.A.I., has recently resigned from his position with Canadian Applied Research to accept a position with the Bendix Aviation Corp., Research Laboratories Division, Detroit.

J. Terajewicz, M.C.A.I., formerly with Canadair Ltd., has accepted a position with the Georgia Division of the Lockheed Airplane Co., as Senior Aerodynamics Engineer.

R. O. Sochaski, Student, has left the University of Saskatchewan and is employed by the Atomic Energy of Canada at Chalk River.

DEATH

It is with deep regret that we announce the death of **A/V/M C. A. Cook, A.F.C.A.I.,** on the 25th July, 1957. He was a keen supporter of the C.A.I. and had served on one of its Committees.

CORRECTION

The June issue of the Journal contained an announcement that **Mr. I. M. Hamer, F.C.A.I.,** had been elected a Fellow of the Royal Architectural Society. This should have read Royal Aeronautical Society—a point of much greater significance. We apologize for the error.

ADMISSIONS

At a meeting of the Council, held on the 26th May, 1957, the following were admitted to the grades of membership shown.

Associate Fellow

M. Bowen, General Manager, Vertol Aircraft Co. (Canada) Ltd., Arnprior, Ont.

C. V. Lindlow, Project Designer, Avro Aircraft Limited, Box 4004, Terminal A, Toronto, Ont.

R. Wallworth, Engineer, Fairey Aviation Company of Canada Ltd., Dartmouth, N.S.: *11 Faulkner St., Dartmouth, N.S.*

Member

M. W. Brauer, Project Engineer, Orenda Engines Ltd., Malton, Ont.: *1494 Avenue Rd., Toronto 12, Ont.*

G. Campbell, Divisional Metallurgist, Thompson Products Ltd., Louth St., St. Catharines, Ont.

T. P. M. Cooper-Slipper, Chief Test Pilot, Orenda Engines Ltd., Malton, Ont.: *6 Firwood Crescent, Toronto 18, Ont.*

G. J. Evans, Executive Asst. to the General Manager, PSC Applied Research Ltd., Toronto, Ont.: *P.O. Box 126, Highland Creek, Ont.*

W. G. Fanstone, Asst. Superintendent Overhaul – Units, Trans-Canada Air Lines, P.O. Box 768, Winnipeg, Man.

LCDR (E) (A/E) E. Gosh, RCN, Officer in charge Project Engr. Div., Experimental Sqdn. Ten, Shearwater, N.S.: *3 Lawnsdale Dr., Dartmouth, N.S.*

L. G. Hobbs, Experimental Test Pilot, Orenda Engines Ltd., Malton, Ont.: *6 Lagos Rd., Rexdale, Ont.*

A. M. Latta, Production Controller and Sub-Contract Manager, Enamel & Heating Products Ltd., Aircraft Division, Amherst, N.S.: *53 Victoria St. W., Amherst, N.S.*

W. Lips, Vice-President and Technical Director, Phoenix Engineered Products Ltd., 750 Lawrence Ave. West, Toronto 10, Ont.

G. Lloyd, Engineer, Canadair Ltd., Montreal, P.Q.: *6100 Rue Nelligan, Cartierville, Montreal, P.Q.*

K. G. Ludlow, Sr. Engineer, Northrop Aircraft Ltd., Hawthorne, Calif.: *137 Paseo de la Concha, Redondo Beach, California.*

J. F. Martin, Design Engineer, Fairey Aviation Company of Canada Ltd., Dartmouth, N.S.: *18 Esdale Ave., Apt. 12, Dartmouth, N.S.*

R. T. Mathias, Eastern District Manager, Leach Corporation, Los Angeles, Calif.: *P.O. Box 5696 Washington 16, D.C.*

F. L. Meeus, President, Intair Ltd., Antwerp Airport, Antwerp 1, Belgium.

R. W. Morrison, Foreman, Trans-Canada Air Lines, Winnipeg, Man.: *202 Conway St., St. James, Man.*

P. Tarnutzer, Engineer, Contraves A.G., Zurich, Switzerland: *P.O. Box 1388, MPO 503, Grande Centre, Alta.*

V. J. Trickett, Field Service Engineer, Canadian General Electric Co., Ltd., Toronto, Ont.: *5500 Homer Ave., Norwood, Cincinnati 12, Ohio.*

Sgt. G. W. Wells, NCO in charge of Snag Crew, RCAF Stn. Cold Lake, Alta.: *Box 1561, MPO 503, Grande Centre, Alta.*

R. S. T. Wilson, Sr. Checker, Engineering Dept., Northwest Industries Ltd., Box 517, Edmonton, Alta.

***Member* (Cont)**

F/L W. A. Yager, Aero. Engr. Control and Records Officer, RCAF Stn. Cold Lake, Alta.: *c/o Officers Mess, MPO 503, Grande Centre, Alta.*

Technical Member

E. H. Birnie, Test Pilot, Bristol Aircraft (Western) Ltd., Winnipeg, Man.: *358 Overdale Blvd., St. James, Man.*

W. Burns, Lead Mechanic Engine O'Haul Dept., Trans-Canada Air Lines, Winnipeg, Man.: *147 Handyside Ave., Winnipeg 8, Man.*

J. A. Cornelius, Technical Writer, Fairey Aviation Company of Canada Ltd., Dartmouth, N.S.: *64 Lakefront Rd., Apt. 8, Dartmouth, N.S.*

F/L J. F. Dyer, Experimental Pilot, RCAF Stn. Cold Lake, Alta.: *Box 1187, MPO 503, Grande Centre, Alta.*

E. G. Enns, Sales Engineer, Muirhead Instruments Ltd., Stratford, Ont.

R. B. Erb, Aerodynamicist, Avro Aircraft Ltd., Box 4004, Terminal A, Toronto, Ont.

R. E. Fluet, Structural Test Engineer, Canadair Ltd., Montreal, P.Q.: *30-4th Ave., Laval West, P.Q.*

J. D. Koppernaes (on transfer from Student).

J. S. Lemick, Tool and Diemaker, Avro Aircraft Ltd., Toronto, Ont.: *348 Windermere Ave., Toronto 3, Ont.*

R. A. Marsh, Aircraft Painter, Trans-Canada Air Lines, Vancouver, B.C.: *2620 Carson St., South Burnaby, B.C.*

Technician

R. A. Schaefer, Apprentice, Northwest Industries Ltd., Edmonton, Alta.: *Duffield, Alta.*

G. B. Taylor, Flight Test, Avro Aircraft Ltd., Toronto, Ont.: *c/o Officers Mess, MPO 503, Grande Centre, Alta.*

N. P. Williamson, Air Traffic Controller, Dept. of Transport, Ottawa, Ont.: *2620 Graham St., Victoria, B.C.*

Student

F/C W. J. Albrecht, Royal Military College, Kingston, Ont.

P/O A. S. Armstrong, Royal Military College, Kingston, Ont.

F/C P. J. Ashley, Royal Military College, Kingston, Ont.

F/C E. Bizon, Royal Military College, Kingston, Ont.

F/C J. E. Booth, Royal Military College, Kingston, Ont.

F/C G. S. Boyington, Royal Military College, Kingston, Ont.

F/C R. G. W. Brewer, Royal Military College, Kingston, Ont.

E. N. Bryga, Royal Military College, Kingston, Ont.

Cadet L. J. E. Byer, Royal Military College, Kingston, Ont.

P/O J. P. A. Cadieux, Royal Military College, Kingston, Ont.

P/O B. R. Carter, Royal Military College, Kingston, Ont.

F/C H. W. Causier, Royal Military College, Kingston, Ont.

M. Cote, Royal Military College, Kingston, Ont.

F/C E. R. Cross, Royal Military College, Kingston, Ont.

F/C F. G. Forrington, Royal Military College, Kingston, Ont.

Cadet E. Gagosz, Royal Military College, Kingston, Ont.

F/C D. E. Galloway, Royal Military College, Kingston, Ont.

F/O D. J. Gilpin, Royal Military College, Kingston, Ont.

F/C G. W. Gooderham, Royal Military College, Kingston, Ont.

F/C R. W. Hallworth, Royal Military College, Kingston, Ont.

F/C G. H. Herbert, Royal Military College, Kingston, Ont.

Cadet R. J. Hicks, Royal Military College, Kingston, Ont.

Cadet H. M. Howard, Royal Military College, Kingston, Ont.

F/C W. I. Hughes, Royal Military College, Kingston, Ont.

F/C D. G. Jaques, Royal Military College, Kingston, Ont.

Cadet R. F. Jefferies, Royal Military College, Kingston, Ont.

P/O W. D. Johnston, Royal Military College, Kingston, Ont.

F/C D. S. Karn, Royal Military College, Kingston, Ont.

F/C C. S. Kemp, Royal Military College, Kingston, Ont.

P. B. Kristjansen, Royal Military College, Kingston, Ont.

F/C D. J. R. Larrigan, Royal Military College, Kingston, Ont.

F/C N. R. Lee, Royal Military College, Kingston, Ont.

J. Y. Lemieux, Royal Military College, Kingston, Ont.

F/O C. E. Lowthian, Royal Military College, Kingston, Ont.

Cadet R. J. Madge, Royal Military College, Kingston, Ont.

Cadet N. J. Marcotte, Royal Military College, Kingston, Ont.

F/C J. R. Marshall, Royal Military College, Kingston, Ont.

F/C D. G. McBride, Royal Military College, Kingston, Ont.

F/C R. W. McIntosh, Royal Military College, Kingston, Ont.

F/C R. B. McQuiggan, Royal Military College, Kingston, Ont.

F/C D. F. Moffatt, Royal Military College, Kingston, Ont.

N/C T. M. Moore, Royal Military College, Kingston, Ont.

P/O S. G. Morin, Royal Military College, Kingston, Ont.

Cadet T. K. Morton, Royal Military College, Kingston, Ont.

Cadet J. R. Norgate, Royal Military College, Kingston, Ont.

F/C W. A. Petersen, Royal Military College, Kingston, Ont.

Cadet R. M. Ramsbottom, Royal Military College, Kingston, Ont.

F/C J. P. Reilly, Royal Military College, Kingston, Ont.

O/C G. D. Richardson, Royal Military College, Kingston, Ont.

F/C G. R. Riddell, Royal Military College, Kingston, Ont.

P/O W. N. Russell, Royal Military College, Kingston, Ont.

F/C R. B. Smale, Royal Military College, Kingston, Ont.

F/C B. D. Smallman-Tew, Royal Military College, Kingston, Ont.

F/C I. K. Steuart, Royal Military College, Kingston, Ont.

A. C. Stevenson, Royal Military College, Kingston, Ont.

Cadet M. L. Taylor, Royal Military College, Kingston, Ont.

R. B. Teague, Royal Military College, Kingston, Ont.

N/C J. M. Treddenick, Royal Military College, Kingston, Ont.

F/O D. W. Tufts, Royal Military College, Kingston, Ont.

F/C G. Vrana, Royal Military College, Kingston, Ont.

Cadet R. F. Walton, Royal Military College, Kingston, Ont.

F/C D. E. Weese, Royal Military College, Kingston, Ont.

F/C D. E. Wright, Royal Military College, Kingston, Ont.

Associate

J. H. Johnston, Specialist, Sales and Production Planning, Aviation Equipment, Canadian General Electric Co., Ltd., 830 Lansdowne Ave., Toronto, Ont.

F/L K. E. Lewis, RCAF, Canadian Services College, Royal Roads, Victoria, B.C.

* * *

At a meeting of the Admissions Committee, held on the 6th June, 1957, the following were admitted to the grades of membership shown.

Associate Fellow

L. H. Berwick (on transfer from Member)

S/L W. M. McLeish (on transfer from Member)

S. J. Pope, Section Chief, Aerodynamics, Engineering Dept., Canadair Ltd., P.O. Box 6087, Montreal, P.Q.

Member

S/L V. L. Bradley, Staff Officer Cataloguing and Publications, AFHQ, Ottawa, Ont.: *187 Faraday St., Ottawa, Ont.*

N. S. Currey (on transfer from Technical Member)

F/O H. Grinnell, Officer in charge Engineering Data Section, AMC/RCAF, Ottawa, Ont.: *39 Mynarski Crescent, Ottawa 2, Ont.*

F. Hickinbotham, Engineer, Canadair Ltd., Montreal, P.Q.: *2045 St. Germain Blvd., St. Laurent, Montreal 9, P.Q.*

M. E. Holloway, Field Service Engineer, Canadair Ltd., Montreal, P.Q.: *P.O. Box 403, RCAF Stn. Uplands, Ottawa, Ont.*

C. J. D. Hughes, Field Service Representative, Avro Aircraft Ltd., Malton, Ont.: *c/o Officers' Mess, MPO 503, Grande Centre, Alta.*

P. F. Leigh-Mossley (on transfer from Technical Member)

W/C H. J. Massiah, Staff Officer Aero. Engineering, Air Defence Command, St. Hubert, P.Q.: *Box 189, RCAF Stn. St. Hubert, P.Q.*

D. G. McCrea (on transfer from Technical Member)

J. R. Storry, Aircraft Planning Supervisor, Bristol Aircraft (Western) Ltd., Winnipeg, Man.: *1134 Clifton Pl., Winnipeg 3, Man.*

PO E. S. Sunderland, Air Technician—Instructor, RCN Air Station, Shearwater, N.S.: *18 Martlett Place, Shearwater, N.S.*

F/L G. Taylor, Post-graduate Student at McGill University, Montreal, P.Q.: *6530 Monkland Ave., Apt. 38, Montreal, P.Q.*

J. A. van der Bliek (on transfer from Technical Member)

W. G. Wilkins, Designer, Avro Aircraft Ltd., Box 4004, Terminal A, Toronto, Ont.

Technical Member

D. F. Black (on transfer from Student)

A. J. Comeau, Jr. Engineer, Avro Aircraft Ltd., Malton, Ont.: *c/o Officers' Mess, MPO 503, Grande Centre, Alta.*

F. L. Gilbertson (on transfer from Student)

W. M. H. Grover (on transfer from Student)

E. P. Muntz (on transfer from Student)

V. D. Prendergast (on transfer from Student)

F. E. Prentice, Quality Control Rep., 1004 TSD, Dept. of National Defence, Ottawa, Ont.: *42 Moore Ave., St. Vital, Winnipeg, Man.*

Technician

R. M. Barnes, Tooling Co-ordinator, Enamel & Heating Products Ltd., Amherst, N.S.: 7 *Rupert St., Amherst, N.S.*

C. S. Melander (on transfer from Student)

R. J. St. Cyr (on transfer from Student)

Associate

Mrs. G. G. Ross, Assistant to the Secretary, Canadian Aeronautical Institute, 77 Metcalfe St., Ottawa, Ont.

* * *

At a meeting of the Admissions Committee, held on the 20th June, 1957, the following were admitted to the grades of membership shown.

Associate Fellow

J. T. Dyment, Director of Engineering, Trans-Canada Air Lines, International Aviation Bldg., Montreal, P.Q.

C. P. L. Nicholson (on transfer from Member)

Member

R. G. Bijoor (on transfer from Technical Member)

I. B. Braverman (on transfer from Technical Member)

J. N. Dykshoorn (on transfer from Technical Member)

H. W. Horn, Personal Estate Management, 3745 Edgemont Blvd., North Vancouver, B.C.

CDR H. J. Hunter (on transfer from Associate)

C. H. Orchard (on transfer from Technical Member)

R. C. Warren (on transfer from Technical Member)

Technical Member

W. P. Ewanchyna (on transfer from Technician)

D. W. Graham (on transfer from Technician)

N. E. C. Johnson, Technical Writer, De Havilland Aircraft of Canada Ltd., Downsview, Ont.: *20 Katherine Ave., Downsview, Ont.*

G. R. Ludwig (on transfer from Student)

W. S. C. McLaren (on transfer from Student)

Technician

R. H. Skeldon (on transfer from Student)

R. C. Isaac (on transfer from Student)

W. A. Jones (on transfer from Student)

* * *

At a meeting of the Admissions Committee, held on the 24th June, 1957, the following were admitted to the grades of membership shown.

Member

W. E. Bennett, Sr. Electronic Engineer, Northwest Industries Ltd., Edmonton, Alta.: *11625 - 132nd St., Apt. 12, Edmonton, Alta.*

WO1 O. Carnahan, SOAE Branch, Staff Duties, ADCHQ, RCAF Stn. St. Hubert, P.Q.: *40 Pine Circle, RCAF Stn. St. Hubert, P.Q.*

T. N. Chapman, Field Service Rep., Avro Aircraft Ltd., Malton, Ont.: *4870 Cote des Neiges Rd., Apt. 601, Montreal, P.Q.*

F/L D. W. Cooke, Maintenance Research and Analysis, AMC HQ, RCAF Stn. Rockcliffe, Ottawa, Ont.: *503 Brittany Dr., Ottawa 2, Ont.*

W/C D. O. Coons, Staff Officer for Aviation Medicine, RCAF HQ, Ottawa, Ont.: *1198 Checkers Rd., Ottawa 3, Ont.*

D. A. Dixon, Manager, Aircraft Mfg. Eng. Dept., Canadair Ltd., Montreal, P.Q.: *5175 Cote St. Luc Rd., Apt. 8, Montreal 28, P.Q.*

Dr. W. B. Fallis, Group Engineer, Theoretical Aerodynamics, Convair, Division of General Dynamics Corporation, Fort Worth, Texas: *4612 Rutland Ave., Fort Worth, Texas.*

CPO J. H. Gower, RCN, Staff of Naval Aircraft Overseer, c/o De Havilland Aircraft of Canada Ltd., Downsview, Ont.: *12 Second Ave., Rexdale, Ont.*

F. M. Haines, Production Director, Canadian Applied Research Ltd., 1500 O'Connor Dr., Toronto 16, Ont.

Member (Cont)

F/L H. E. Hendrickson, Aeronautical Eng. Officer, ADC HQ, RCAF Stn. St. Hubert, P.Q.: *220 Green St., St. Lambert, P.Q.*

F/O K. W. Joy, Engineering Procedures & Standards, AMC HQ, RCAF Stn. Rockcliffe, Ottawa, Ont.: *757 Chapman Blvd., Ottawa 1, Ont.*

LCDR W. W. Maxwell, Training Officer, Naval Aircraft Maint. School, Dept. of National Defence (Navy), Ottawa, Ont.: *14 Lawnsdale Dr., Dartmouth, N.S.*

Technical Member

C. R. Bristow, Lead Mechanic, Trans-Canada Air Lines, Winnipeg, Man.: *42 Bruce Ave., St. James, Man.*

E. H. Collins, Field Service Engineer, Sperry Gyroscope Co. of Canada, Montreal, P.Q.: *6180 Nelligan St., Apt. 12, Montreal 9, P.Q.*

J. M. Davey, Mathematical Engineer, Orenda Engines Ltd., Malton, Ont.: *46 Saranac Blvd., Apt. 6, Toronto 10, Ont.*

J. Gill, Helicopter Engineer, Okanagan Helicopters Ltd., Vancouver Airport, B.C.

L. M. Gosselin, Checker Draftsman, Trans-Canada Air Lines, Montreal, P.Q.: *10556 Laverdure, Ahuntsic, Montreal, P.Q.*

A. A. P. McGowan, Research and Development Engineer, Orenda Engines Ltd., Malton, Ont.: *Apt. B1, Court 2, Amedeo Gardens Court, 415 Lake Shore Rd., Mimico, Toronto 14, Ont.*

Student

Cadet D. Didicher, Royal Military College, Kingston, Ont.

Associate

Dr. W. O. Coates, Surgeon, 72 Church St., Amherst, N.S.

S/L T. A. Gallagher, RAF, Personnel Branch, Maintenance Command, Royal Air Force, Amport, Hants, England.

* * *

At a meeting of the Admissions Committee, held on the 8th July, 1957, the following were admitted to the grades of membership shown.

Associate Fellow

C. A. Ulsh, Aircraft Manufacturing Director, Canadair Ltd., P.O. Box 6087, Montreal, P.Q.

Member

W. S. Bacon, Instrumentation Engineer, Computing Devices of Canada Ltd., Ottawa, Ont.: *143 Cavendish Rd., Ottawa, Ont.*

J. Q. Calkin (on transfer from Technical Member)

R. S. Campbell, Aircraft Factory Manager, Canadair Ltd., P.O. Box 6087, Montreal, P.Q.

J. L. Fernandez, Planning Engineer (Northern Div.), Pacific Western Airlines, Edmonton, Alta.: *11254 - 116 St., Ste. 1, Edmonton, Alta.*

J. A. Mitchell, Engineering Dept., Trans-Canada Air Lines, Dorval, P.Q.: *535 Cedar St., Beaurepaire, P.Q.*

F/L J. Moffat, Range Instrumentation Officer, CEPE/AAED RCAF Stn. Cold Lake, Alta.: *MPO 503, Grande Centre, Alta.*

S. Paskins, Engineer Airframe Design, Canadair Ltd., Montreal, P.Q.: *3762 De la Peltrie, Montreal 26, P.Q.*

D. G. Pitt, Superintendent, The Fairey Aviation Co., Ltd., Hamble, Near Southampton, Hampshire, England.

P. F. Sanders, Field Service Representative, Canadair Ltd., Montreal, P.Q.: *c/o Officers' Mess, RCAF Stn., Saskatoon, Sask.*

L. Stachtchenko, Dynamics Analysis Engineer, Canadair Ltd., Montreal, P.Q.: *4809 Western Ave., Montreal, P.Q.*

E. G. Suarez, General Manager, Field Aviation Company Ltd., P.O. Box 366, Oshawa, Ont.

W. S. Tearle, Production Manager, Vertol Aircraft Co. (Canada) Ltd., Arnprior, Ont.: *15 First Ave., Arnprior, Ont.*

Technical Member

W. A. Anderson, Air Engineer, Edmonton Flying Club, Edmonton, Alta.: *11366 - 110A Ave., Edmonton, Alta.*

Lt. D. S. Chandler, Project Pilot, Experimental Squadron Ten, RCN Air Station, Shearwater, N.S.

M. Coupland, Salesman, Aircraft Equipment Sales, Railway & Power Engineering Corp. Ltd., Montreal, P.Q.: *48 St. Joseph St., Dorval, P.Q.*

H. G. Fredericks, Draftsman, Northwest Industries Ltd., Edmonton, Alta.: *11715 - 124 St., Edmonton, Alta.*

G. W. Grover (on transfer from Student)

W. G. Hazel, Chargehand, Fairey Aviation Company of Canada Ltd., Dartmouth, N.S.: *c/o A. Saunders, Eastern Passage, N.S.*

J. H. Reid, Experimental Budget Controller, Avro Aircraft Ltd., Malton, Ont.: *R.R. 1, Shelburne, Ont.*

S. B. Savage, 258 Sherbrooke West, Montreal, P.Q.

J. L. Sullivan, Aircraft Div. Engineer, Thompson Products Ltd., Louth St., St. Catharines, Ont.

M. G. Tigwell, Design Draftsman, De Havilland Aircraft of Canada Ltd., Downsview, Ont.: *24 Anglesey Blvd., Apt. 12, Toronto 18, Ont.*

D. C. Turner, Maintenance Controller, Pacific Western Airlines Ltd., Patricia Bay, Sidney, B.C.

R. Wharmby, Design Draftsman, Avro Aircraft Ltd., Malton, Ont.: *25 Jane Osler Blvd., Toronto 10, Ont.*

Technician

H. L. Scott, Product Engineer, De Havilland Aircraft of Canada Ltd., Downsview, Ont.: *Stevenson Rd., R.R. 3, Weston, Ont.*

Associate

J. R. Burnside, Special Weapons Contract Administrator, Canadair Ltd., P.O. Box 6087, Montreal, P.Q.

JOINT I.A.S./C.A.I. MEETING

Programme

October 21st Morning 9.00 a.m.

NAVIGATION AND AIR TRAFFIC CONTROL

Chairman
C. C. Bogart
Chief Air Traffic Control Division
Department of Transport

Global Navigation in High Speed Aircraft
W/C K. R. Greenaway
Royal Canadian Air Force

Flying the Jet Stream
P. R. J. Reynolds
Navigation Superintendent
C. L. Chandler
Meteorologist
Pan American World Airways

Jet Weather
P. D. McTaggert-Cowen
Assistant Director and Chief, Forecast Division,
Meteorological Branch, Department of Transport

PROPULSION

Chairman
C. A. Grinyer
Vice-President Engineering
Orenda Engines Limited

Recent Advances in The Aerodynamic Design of Axial Turbo-Machinery
W. H. Robbins, H. W. Plohr
Aeronautical Research Engineers
Lewis Flight Propulsion Laboratory, NACA

Gas Turbine Combustion System Design
F. D. M. Williams
Chief Development Engineer, Controls,
Orenda Engines Limited

Power for Man's First Space Venture
H. M. Weber
Rocket Engine Section, General Electric Company

Afternoon 2.30 p.m.

THE W. RUPERT TURNBULL LECTURE

Chairman
Dr. J. J. Green
Defence Research Member,
Canadian Joint Staff, Washington

Aerophysical Problems of Flight at Extreme Altitudes and Speeds
Dr. G. N. Patterson
Director, Institute of Aerophysics

Evening 7.00 p.m.

DINNER

Chairman
G/C H. R. Foottit
President, Canadian Aeronautical Institute
Director of Aircraft Engineering, R.C.A.F.

Principal Speaker
G. R. McGregor
President, Trans-Canada Air Lines
The Economics of Civil Turbine Operation

October 22nd Morning 9.00 a.m.

SPECIAL TECHNIQUES

Chairman
R. D. Hiscocks
Asst. Chief Engineer
De Havilland Aircraft of Canada Limited

Stability and Control Characteristics of the Vertical Attitude VTOL Aircraft
E. R. Hinz
Unit Chief, Systems and Controls
Ryan Aeronautical Co.

Simulated Flight Training — Its Uses and Limitations
Captain G. B. Lothian
Superintendent of Flying
D. J. Woodward
Simulated Flight Training Supervisor
Trans-Canada Air Lines

Standby Rocket Engines for Civil Aircraft
G. E. Rice
Commercial JATO Sales, Aerojet-General Corp.

EDUCATION AND TRAINING

The Shortage of Technical Personnel — An informal discussion
Moderator
Professor T. R. Loudon
Asst. to Chief Engineer and Director of Training
De Havilland Aircraft of Canada Limited
A. E. Ades
Asst. Director of Engineering, Trans-Canada Air Lines
W. A. B. Saunders
Vice-Principal, Provincial Institute of Technology and Art, Calgary
W. H. Arata, Jr.
Chief Operations Engineer, Fairchild Aircraft,
Division of Fairchild Engine and Airplane Corp.
C. D. Perkins
Chairman, Aeronautical Engineering Dept.,
Princeton University

Afternoon 2.00 p.m.

SPACE VEHICLES

Chairman
Dr. J. E. Keyston
Vice-Chairman, Defence Research Board

Composition of the Upper Atmosphere
Dr. G. Herzberg
Director, Division of Pure Physics
National Research Council

Project Vanguard — Report of Progress
H. Cohen
Quality Control Project Manager,
The Martin Company

Exit and Re-entry Problems
Dr. G. V. Bull
Head, Aerophysics Section
Dr. K. R. Enkenhus
Head, Aerodynamics Group
G. H. Tidy
Head, Hypersonics Group
Canadian Armament Research and Development Establishment

AIRLINE OPERATIONS

Chairman
A/V/M A. Ferrier
Asst. Secretary General, Air Navigation, I.C.A.O.

Important Factors in Aviation Safety
R. M. Woodham
Associate Director
Cornell-Guggenheim Aviation Safety Center

When is an Aircraft a "Nuisance" in the Eyes of the Law?
A. R. Paterson
Solicitor, Blake, Cassels & Graydon

Scheduled Helicopters — The Year 1960
R. L. Cummings, Jr.
President, New York Airways, Inc.

SUSTAINING MEMBERS

NEWS

PSC Applied Research Ltd., shortly after joining the A. V. Roe Canada Group, changed its name to Canadian Applied Research Ltd.

Besides its present plant and offices at 1500 O'Connor Dr., Toronto, the firm has just moved into an additional 16,000 sq ft area on Bermondsey Road where production facilities are being installed for the manufacture of the Company's larger varieties of special instruments, like the Gamble Plotter for topographic map-making from aerial photographs, the Automatic Tri-Film Processor for the fast development and drying of motion picture film and Instrumentation Cameras for all types of scientific recording needs. The addition now provides 56,000 sq ft for the firm's engineering, production and environmental test laboratory facilities.

This is an interim expansion pending construction of a completely air-conditioned plant now being planned in North Toronto. It is expected the new site will be occupied in two years.

Northwest Industries Ltd. have announced the completion of their new Instrument and Electronic Laboratory. The new brick and steel, single-storey building with a floor area of 19,500 sq ft is temperature and humidity controlled and is fully equipped with up-to-date repair and testing facilities, including environmental testing.

The new Laboratory, which replaces one destroyed by fire last year, includes a completely equipped Dial Studio for the preparation of luminizing of instrument dials and related components; this studio was inaugurated in 1955 to provide facilities which, at the time, did not exist in Western Canada. In addition to extensive work in the repair, overhaul, testing and modification of the complete range of aircraft instruments, airborne and ground telecommunications and radar equipment, research and development work in the radar field is being carried out. The latter includes development and installation of weather and search electronic equipment on the C-119 series aircraft.

Northwest Industries Limited Instrument and Electronic Laboratory

Honeywell Controls Ltd. have been awarded a contract for a Command Signal Limiting system for the CF-100. This system monitors the signals from the fire control system to protect the aircraft against self-imposed structural overloads; it enables the aircraft to follow its target by manoeuvres which both the aircraft and the crew can withstand. Although preliminary design work and manufacture were done at the Aeronautical Division plant at Minneapolis, the bulk of the design and assembly is being carried out at the Honeywell plant in Toronto.

Avro Aircraft Ltd. and Orenda Engines Ltd. have joined the new co-operative scheme inaugurated last July by Waterloo College. The scheme consists of a six-year course in which students alternate, in three-month sessions, between industry and college, eventually graduating with a B.Sc. degree.

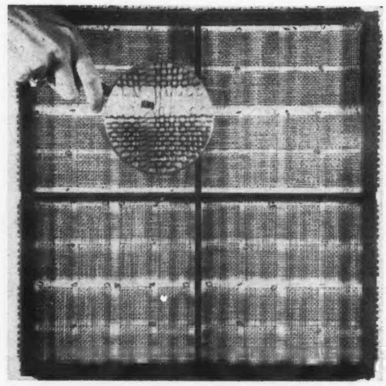
Avro Aircraft Ltd. has been awarded a Mutual Aid contract for the supply of CF-100 aircraft to Belgium. This is the first time that a Canadian designed and built military aircraft has been selected by another country and Avro Aircraft and Orenda Engines are to be congratulated on the achievement.

Orenda Engines Ltd. staged a ceremony for the unveiling of the Iroquois on the 22nd July. The unveiling was performed by Mr. G. R. Pearkes, V.C., Minister of Defence, in the presence of Air Marshal C. R. Slemon, C.A.S., and Air Attachés from five NATO countries.

The Iroquois weighs less per pound of thrust than any other large supersonic engine known to be running to date.

A point made by Mr. McLachlan in connection with this achievement concerned the teamwork which had been necessary, not only within the Orenda organization but throughout Canada – in the RCAF, Government Establishments and Universities and more than 2,000 firms in supporting industries.

Computing Devices of Canada Ltd. have issued a description of what is believed to be the largest magnetic core memory unit ever assembled in one piece. This core array is intended for use in a 1,000 channel kicksorter for Atomic Energy of Canada Ltd.



Computing Devices' Magnetic Core Memory

The intricate array includes 16,384 minute doughnut-shaped magnetic cores, threaded on fine insulated wires; four of these wires pass through each core; two of them pass in straight lines from each side of the array to the other, while two more are threaded in a complicated zig-zag path through the cores.

Approximately 400 hours of labour went into the manufacture of the unit, the first of three to be constructed. The job required great care and precision. The cores, so tiny that a hundred can be put in a thimble, are placed so closely in the array that they almost touch. There is only one correct position and path for each wire and an error discovered on test may mean a great deal of work in rethreading wires.

Aside from the speed of access to information, the magnetic core memory unit has another definite advantage. As a static device, with no moving parts, it has a very high reliability. Tests to date on units made in the United States indicate reliability may be infinite. Intermittent faults, a major problem with electronic components such as tubes and condensers, have never been known to occur in magnetic cores.

Dorval Metalcraft Co. announced that it has incorporated with the Company of L. Lloyd Davies & Associates to form a new Company known as Air-ex Incorporated. (The Company will be shown as Air-ex Incorporated in future lists of Sustaining Members.)

SUSTAINING MEMBERS

of the

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1957-58

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SPECIALIST SECTIONS

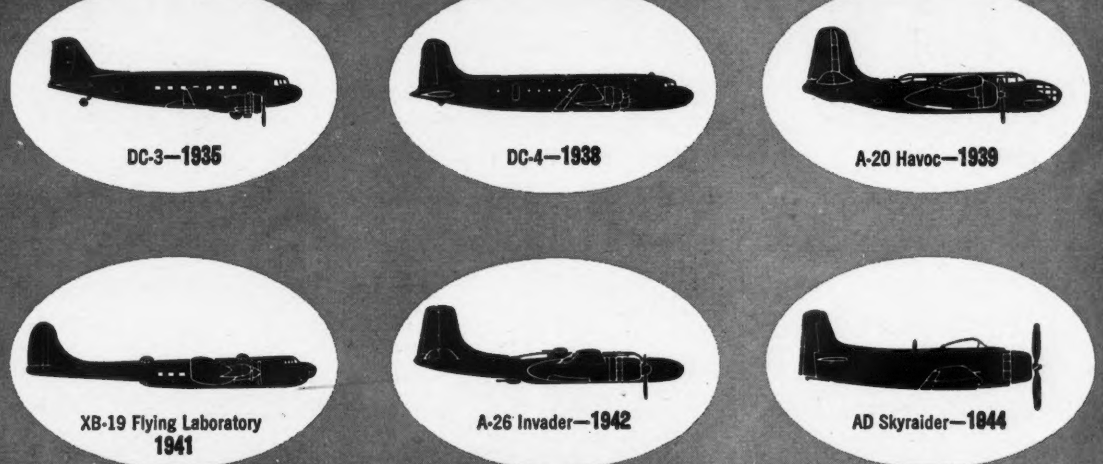
The structure of the Canadian Aeronautical Institute provides for the formation of Sections devoted to special fields of aeronautical work. Each Section is, in effect, a specialist society, operating within the framework of the Institute and using the Institute's facilities.

A Section is similar to a Branch in that it is administered by an Executive Committee which is elected by the members of the Section. The essential difference between the two lies in the qualifications for membership; a member of a Branch must live in the area served by the Branch, whereas a member of a Section must possess technical qualifications appropriate to the field served by the Section. Members of the C.A.I. may belong to as many Sections as they wish, provided they possess the necessary qualifications, at no additional cost in the form of dues etc.

A Test Pilots Section was formed in November 1956 and steps are now being taken to form a Propulsion Section.

Any other groups of specialists who wish to promote the formation of Sections, in which they can further their own technical interests, should get in touch with

The Secretary
Canadian Aeronautical Institute
Commonwealth Building
77 Metcalfe Street
Ottawa, Ontario.



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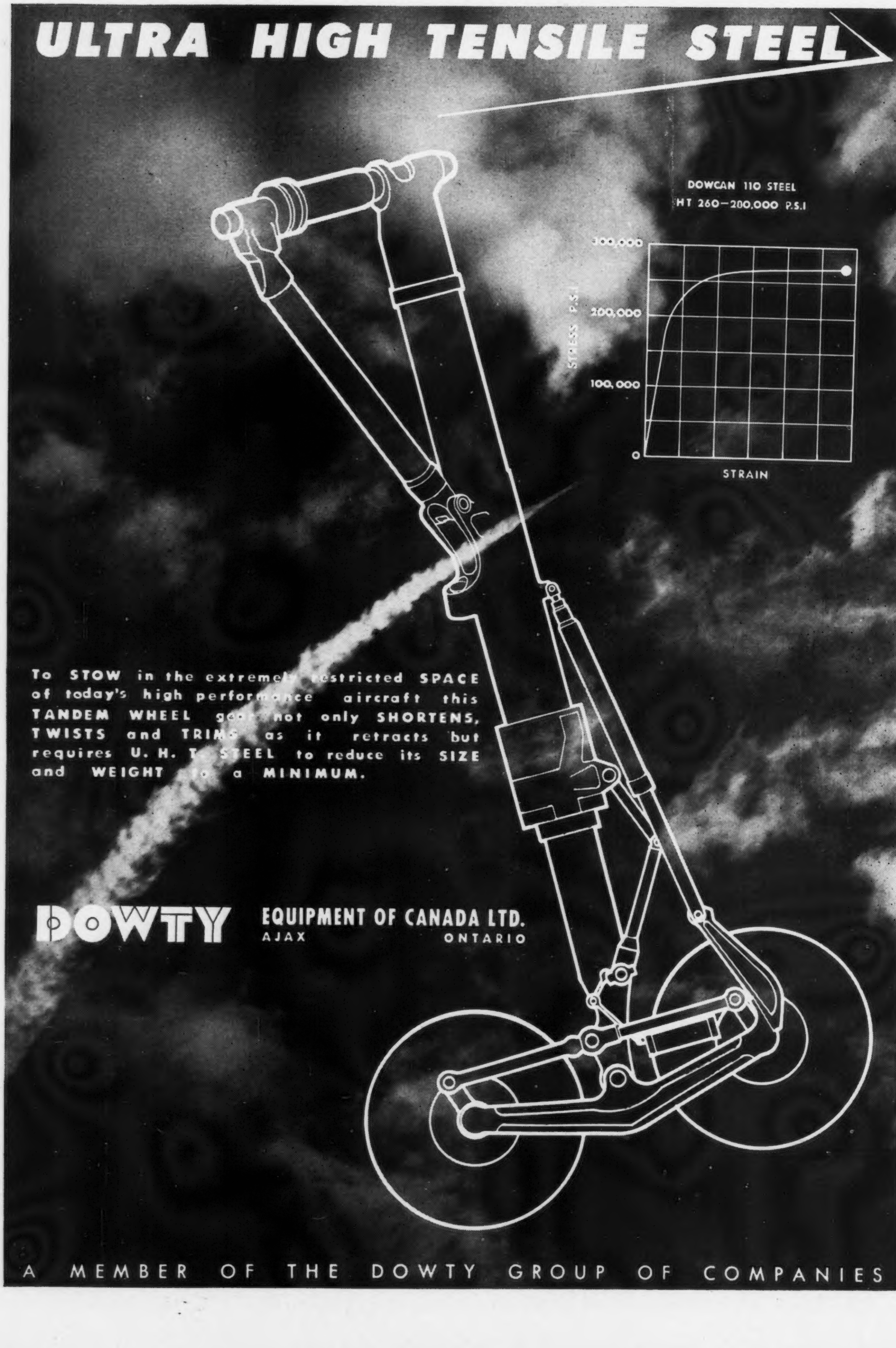

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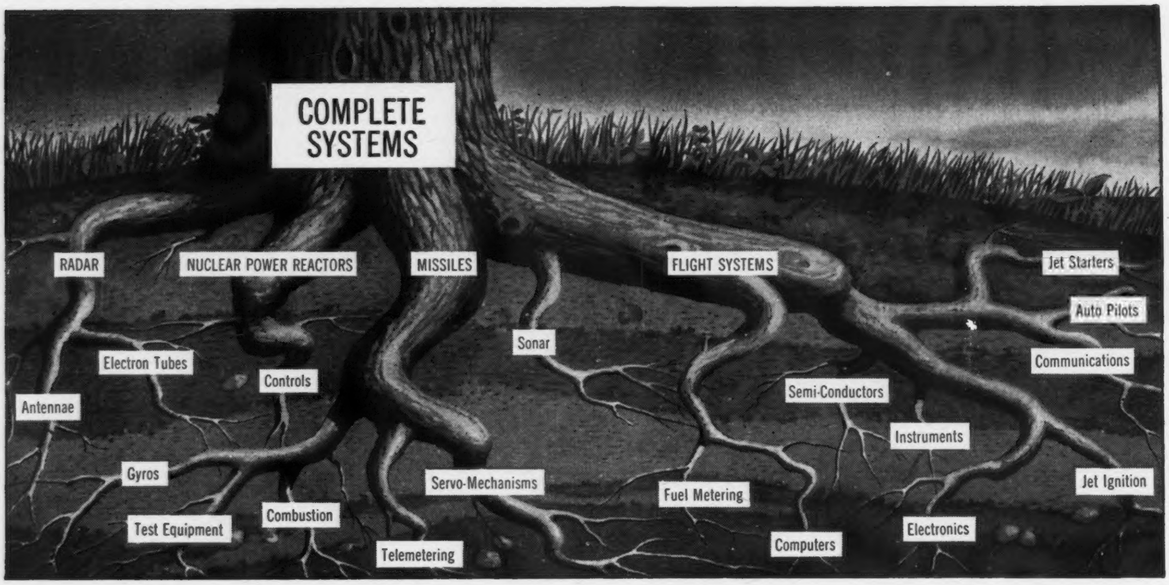

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